# Table of Contents

**INTRODUCTION**  
On-Line Support .................................................................................................................. 3  
Limited Warranty & Limitation of Liability ......................................................................... 4  
Safety Information: Read First ............................................................................................. 6

**QUICK START**  
Install Engineering Data management (EDM) software to PC ..................................... 8  
Where is My License Key? ................................................................................................. 16  
USB Device Driver .............................................................................................................. 17  
EDM Software Update ......................................................................................................... 17  
Recording Time Streams with CoCo-80 ............................................................................ 17  
Download Data to the PC .................................................................................................. 18  
Important Notice about the Concept of CSA .................................................................. 18

**BASIC COCO-80 OPERATION**  
CoCo-80 User Interface ...................................................................................................... 20  
Summary of Buttons ............................................................................................................ 20  
Status Bar ............................................................................................................................ 24  
Welcome Screen .................................................................................................................. 25  
Analysis Button .................................................................................................................. 25  
Display Button ..................................................................................................................... 27  
Signal Display Soft Buttons ............................................................................................... 32  
Input Channel Table Settings ............................................................................................ 36  
Display Window Types ........................................................................................................ 50  
Setup Button ...................................................................................................................... 51  
File Button .......................................................................................................................... 61  
Rec./Stop Button ................................................................................................................ 64  
Save Button ......................................................................................................................... 65  
Next Trc (Trace) Button ...................................................................................................... 65  
View Mode Button .............................................................................................................. 65  
(User) Button ...................................................................................................................... 65  
Recall Button ....................................................................................................................... 65  
Trg (Trigger) On/Off Button ............................................................................................... 66  
Sensor Button ...................................................................................................................... 66  
CoCo-80 Startup and Shutdown ......................................................................................... 69  
Power on and off the CoCo-80 ......................................................................................... 69
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Reset</td>
<td>69</td>
</tr>
<tr>
<td>Keypad Lock</td>
<td>70</td>
</tr>
<tr>
<td><strong>HARDWARE</strong></td>
<td>71</td>
</tr>
<tr>
<td>CoCo-80 Input Connections</td>
<td>71</td>
</tr>
<tr>
<td>System Calibration</td>
<td>71</td>
</tr>
<tr>
<td>Input Modes</td>
<td>71</td>
</tr>
<tr>
<td>CoCo-80 Output Connections</td>
<td>72</td>
</tr>
<tr>
<td>CoCo-80 Peripherals and Accessories</td>
<td>73</td>
</tr>
<tr>
<td>Ethernet</td>
<td>74</td>
</tr>
<tr>
<td>USB Ports</td>
<td>75</td>
</tr>
<tr>
<td>Mouse Support</td>
<td>76</td>
</tr>
<tr>
<td>SD Card Interface</td>
<td>76</td>
</tr>
<tr>
<td>Audio Devices</td>
<td>76</td>
</tr>
<tr>
<td>Battery</td>
<td>76</td>
</tr>
<tr>
<td>Battery Charger</td>
<td>77</td>
</tr>
<tr>
<td>DC/DC Converter for Car Cigarette</td>
<td>77</td>
</tr>
<tr>
<td>CoCo-80 On-Line Updates</td>
<td>78</td>
</tr>
<tr>
<td><strong>CSA — CONFIGURABLE SIGNAL ANALYSIS</strong></td>
<td>79</td>
</tr>
<tr>
<td>Preprogrammed CSA projects</td>
<td>80</td>
</tr>
<tr>
<td>Change CSA projects from the CoCo-80</td>
<td>83</td>
</tr>
<tr>
<td>Editing CSA from the EDM Software</td>
<td>83</td>
</tr>
<tr>
<td><strong>SIGNAL PROCESSING IN THE COCO</strong></td>
<td>84</td>
</tr>
<tr>
<td>The Data Processing Flow of CoCo</td>
<td>84</td>
</tr>
<tr>
<td>Acquisition Modes</td>
<td>86</td>
</tr>
<tr>
<td>Acquisition Mode Setup</td>
<td>90</td>
</tr>
<tr>
<td>Using a Trigger During Measurement</td>
<td>92</td>
</tr>
<tr>
<td>Built-In Digital Integration</td>
<td>95</td>
</tr>
<tr>
<td>Sensor Consideration</td>
<td>96</td>
</tr>
<tr>
<td>Calculation Errors in Digital Integration</td>
<td>97</td>
</tr>
<tr>
<td>Digital High-Pass Filter</td>
<td>98</td>
</tr>
<tr>
<td>Using Integration</td>
<td>99</td>
</tr>
<tr>
<td>Example</td>
<td>99</td>
</tr>
<tr>
<td><strong>COCO-80 OPERATION FOR SPECTRAL ANALYSIS</strong></td>
<td>101</td>
</tr>
<tr>
<td>Select a CSA Project</td>
<td>101</td>
</tr>
<tr>
<td>Set Analysis Parameters for Spectral Analysis</td>
<td>101</td>
</tr>
<tr>
<td>Set the Spectrum Type</td>
<td>102</td>
</tr>
</tbody>
</table>
Set the Output Channel Parameters ................................................................. 103
Create Display Window and Set up the Trace .................................................. 104
dB and Linear Magnitude ................................................................................. 105
Set Acquisition Mode ...................................................................................... 106
Set Overlap Ratio ............................................................................................. 106
Select the View Mode ...................................................................................... 107

COCO OPERATION FOR TRANSIENT CAPTURE .............................................. 108
Select a CSA Project ....................................................................................... 108
Analysis Parameters: Window Type ................................................................. 108
Acquisition Mode ............................................................................................ 108
Save Averaged Data ....................................................................................... 112

SAVING AND RECORDING DATA ................................................................. 113
Save Long Time Waveform Signals ................................................................. 113
Save Block Signals ........................................................................................ 115
Save Points ..................................................................................................... 116
Using Schedule to Save Data ......................................................................... 116
Recall Signals ................................................................................................. 118

EDM PC SOFTWARE ......................................................................................... 122
The CoCo DSA Mode of EDM ........................................................................ 125
Data Transfer ................................................................................................. 125
Data Management .......................................................................................... 126
Data Analysis ................................................................................................. 126
CoCo-80 – PC Communication ..................................................................... 126
Transfer Data Files to the Host PC ................................................................. 127
Configuring the CoCo-80 Network Settings .................................................... 128
Configuring the Host PC Network Settings .................................................... 129
Connect CoCo-80 to a PC directly using USB client ........................................ 130
Connect CoCo-80 to a PC directly using Ethernet via crossover cable .......... 130
Connect CoCo-80 to a local network using Ethernet ....................................... 130
Connect CoCo-80 to a local network using wireless SD card ......................... 130
Network Connection Diagnosis .................................................................... 131
Data Format .................................................................................................... 132
ASAM ODS (Open Data Service) ................................................................. 132
UFF Files ....................................................................................................... 133
The Binary 58 Universal File Format (BUFF) .................................................. 134
ASCII UFF .................................................................................................... 135
<table>
<thead>
<tr>
<th>File Formats</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATLAB file</td>
<td>135</td>
</tr>
<tr>
<td>NI-TDM file</td>
<td>135</td>
</tr>
<tr>
<td>User Defined ASCII file</td>
<td>135</td>
</tr>
<tr>
<td>.CSV (Microsoft Excel) File</td>
<td>135</td>
</tr>
<tr>
<td>.WAV File</td>
<td>135</td>
</tr>
</tbody>
</table>

**CSA EDITOR OPERATION FOR SPECTRAL ANALYSIS**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSA Editor Wizard</td>
<td>137</td>
</tr>
<tr>
<td>Select the Signals to Compute</td>
<td>139</td>
</tr>
<tr>
<td>Editing an Arbitrary Waveform</td>
<td>141</td>
</tr>
<tr>
<td>Validation</td>
<td>143</td>
</tr>
</tbody>
</table>

**ADVANCED AUDIO FUNCTIONS**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware Audio Peripherals</td>
<td>144</td>
</tr>
<tr>
<td>Audio Functions</td>
<td>145</td>
</tr>
<tr>
<td>Headphone Listening</td>
<td>146</td>
</tr>
<tr>
<td>Record Voice Annotations</td>
<td>147</td>
</tr>
<tr>
<td>Playback the Voice Annotations on CoCo</td>
<td>147</td>
</tr>
<tr>
<td>Playback the recorded signals from output channel</td>
<td>148</td>
</tr>
</tbody>
</table>

**APPENDIX**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Versions</td>
<td>150</td>
</tr>
<tr>
<td>Declaration of Conformity</td>
<td>151</td>
</tr>
<tr>
<td>EC Declaration of Conformity</td>
<td>151</td>
</tr>
</tbody>
</table>
Introduction

The CoCo-80 (CoCo) is a handheld data recorder, dynamic signal analyzer, and vibration data collector that is ideal for a wide range of industries including automotive, aviation, aerospace, electronics, and military applications that demand easy, quick, and accurate data recording and real-time processing in the field. The CoCo is a low-cost, light-weight, battery powered handheld system with unparalleled performance and accuracy. The user interface of the CoCo is specifically designed to simplify its operation while maintaining the capability of providing a wide variety of analysis functions.

The CoCo hardware platform supports two different software working modes: Dynamic Signal Analyzer (DSA) and Vibration Data Collector (VDC). Each working mode has its own user interface and operation navigation structure. The DSA working mode is designed for mechanical structure analysis, testing, and optimization for electrical, geophysics, and a wide range of other applications. The VDC mode is dedicated to machine vibration data collection, analysis, and trending. This manual will focus on the basic functions of the CoCo and EDM used in DSA mode.

Figure 1: CoCo Hardware

The CoCo is the first battery powered handheld data acquisition system that matches the performance and functionality of high-end systems. The CoCo is equipped with 2, 4, 8, or 16 input channels and can accurately measure and record both dynamic and static signals. The mass flash memory can record 8 channels of streaming signals simultaneously up to 102.4 kHz. An embedded signal source channel provides various signal output waveforms that are synchronized with the input sampling rate.

The CoCo utilizes a dual CPU architecture. An XScale CPU handles the user interface, project configuration, power management, network communication, and all the peripherals. A high-speed floating point DSP manages the data input/output and real-time processing. The CoCo is also configured with large
amounts of RAM and NAND flash memory for mass data storage. Special thermal and low power design elements eliminate the need for a cooling fan and increases the battery operating time. Proprietary hardware technology delivers more than 130 dB of dynamic range for 2, 4, or 8 channel versions. The extremely high dynamic range eliminates the need for multiple front end gain settings. The CoCo can also be operated from a DC power source (which will simultaneously charge the battery) with either the CoCo AC-DC Adapter (P/N CoCo-A11) or an Automotive Cigarette Lighter Adapter (P/N CoCo-A03).

Revolutionary dual, parallel 24-bit A/D converters, digital technology, and unique hardware designed for the CoCo offers more than 130 dB of dynamic range. The high dynamic range and fidelity of the CoCo enables measurement of a wide range of signals, regardless of the input signal magnitude.

Note: the 16 channel version has 100 dB of dynamic range and utilizes selectable input voltage ranges of .1V, 1V and 10V pk-pk.

The CoCo excels in both dynamic and static measurements. When used for dynamic measurements, the input channels offer extremely high-quality dynamic range, signal to noise ratio, cross channel gain match, phase match, and spectrum flatness over an analysis frequency range up to 46.08 kHz. When it is used to measure static or quasi-static signals, it offers very high accuracy at DC or near DC frequency.

For DSA applications the CoCo software stores and organizes the data in the popular ASAM-ODS standard. Data may be exported to other data formats such as UFF, BUFF, NI-TDM, ASCII, MATLAB, Excel, or WAV (exporting as WAV is limited to time waveform data recordings). The ASAM-ODS data standard provides ultimate flexibility and version compatibility. ASAM-ODS data standard is widely supported by the automotive industry and is expanding to aerospace and other areas.

The handheld system is equipped with two USB ports, a 100Base-T Ethernet, an SD card interface, an audio input/output, a 5.7 inch color LCD display, and a keypad. You can connect the CoCo to a PC, download files, and upgrade the software through multiple types of network connections. The user interface of CoCo is specifically designed for easy operation while it maintains the capability of providing a wide variety of analysis functions.

The CoCo weighs less than 1.7 kg. Advanced thermal design eliminates the need for a cooling fan reducing operating noise. The fully charged battery life is up to 8 hours, depending on configuration and usage. An AC adapter can be used at any time to charge the device while simultaneously recording and processing data.
Compared to handheld data acquisition systems and signal analyzers from other providers, the CoCo delivers higher dynamic range, accuracy, and recording throughput rate, and real-time analysis performance. It also provides more powerful communication peripherals.

Because the CoCo is a standalone instrument it does not have the same drawbacks common to PC-tethered data acquisition systems and analyzers, such as unreliable data transfer. The CoCo does not need any additional PC or laptop to operate during field data acquisition. Hence the CoCo-80 is much more reliable and easier to operate.

On-Line Support

To access product information about your CoCo-80, please go to the product page of CI website at: [http://www.go-ci.com/support.asp](http://www.go-ci.com/support.asp), log in with the serial number of the CoCo-80 and the password included in your shipping documents. After you log-in, you will be able to review and download the latest information which is restricted to CoCo80 users, including:

- Product Information
- New CSA projects
- User's Manual
- Shipping and Repair History
- User Forum
- Technical Support
- Software Updates
- Technical Issues
A typical page of the CI Technical Support website is shown below.

Figure 2: Crystal Instruments CoCo Support Site

The latest CoCo-80 application software, device drivers or CSA projects can be downloaded while the CoCo-80 subscription is maintained.

**Limited Warranty & Limitation of Liability**

Each CI product is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is one year for the CoCo-80 hardware and its accessories. The warranty period begins on the date of shipment. Parts, product repairs and services are warranted for 90 days. This warranty extends only to the original buyer or end-user customer of a CI authorized reseller, and does not apply to fuses, disposable batteries or to any product which, in CI’s opinion, has been misused, altered, neglected or damaged by accident or abnormal conditions of operation or handling. CI warrants that
software will operate substantially in accordance with its functional specifications for one year and that it has been properly recorded on non-defective media. CI does not warrant that software will be error free or operate without interruption.

CI authorized resellers shall extend this warranty on new and unused products to end user customers only but have no authority to extend a greater or different warranty on behalf of CI. Warranty support is available if the product is purchased through a CI authorized sales outlet or the Buyer has paid the applicable international price. CI reserves the right to invoice the Buyer for importation costs of repair/replacement parts when product purchased in one country is submitted for repair in another country.

CI's warranty obligation is limited, at CI's option, to refund of the purchase price, free of charge repair, or replacement of a defective product which is returned to a CI authorized service center within the warranty period.

To obtain warranty service, contact your nearest CI authorized service center or send the product, with a description of the difficulty, postage and insurance prepaid (FOB Destination), to the nearest CI authorized service center. CI assumes no risk for damage in transit. Following warranty repair, the product will be returned to Buyer, transportation prepaid (FOB Destination). If CI determines that the failure was caused by misuse, alteration, accident or abnormal condition of operation or handling, CI will provide an estimate of repair costs and obtain authorization before commencing the work. Following repair, the product will be returned to the Buyer transportation prepaid and the Buyer will be billed for the repair and return transportation charges.

This warranty is the buyer's sole and exclusive remedy and is in lieu of all other warranties, express or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose. CI shall not be liable for any special, indirect, incidental or consequential damages or losses, including loss of data, whether arising from breach of warranty or based on contract, tort, reliance or any other theory.

Since some countries or states do not allow limitation of the term of an implied warranty, or exclusion or limitation of incidental or consequential damages, the limitations and exclusions of this warranty may not apply to every buyer. If any provision of this Warranty is held invalid or unenforceable by a court of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.

Crystal Instruments Corporation, [www.go-ci.com](http://www.go-ci.com)
Safety Information: Read First

The CI CoCo-80 Handheld Data Acquisition System complies with:


Use the CoCo-80 and its accessories only as specified in this User’s Manual.

Condensation may form on the circuit boards when the device is moved from a cold environment to a warm one. In these situations, always wait until the device warms up to room temperature and is completely dry before turning it on. This acclimatization period should take about 2 hours.

For the most accurate measurements a warm-up phase of 20 min is recommended.

The devices have been designed for use in clean and dry environments. It is not to be operated in 1) exceedingly dusty and/or wet environments; 2) in environments where danger of explosion exists; or 3) in environments containing aggressive chemical agents.

Always lay cables in a manner to avoid tripping hazards.

A Warning identifies conditions and actions that pose hazard(s) to the user. A Caution identifies conditions and actions that may damage the Instrument.

To avoid electrical shock or fire:

1. The CoCo is only to be used as a low voltage measurement instrument.
2. Do not apply input voltages above the rating of the Instrument. You should never apply a voltage that potentially exceeds ±40V to the instrument.
3. Review the entire manual before use of the instrument and its accessories.
4. Do not operate the instrument around explosive gas or vapor.
5. Before use, inspect the instrument, BNC connectors, and accessories for mechanical damage and replace when damaged. Look for cracks or missing plastic. Pay special attention to the insulation surrounding the connectors.
6. Remove cables and accessories when not in use.
7. Use the ground input only to ground the instrument. Never apply any voltage.
8. Do not insert metal objects into the connectors.
9. Use only the wall-mount power supply provided by Crystal Instruments.
AC Adapter Voltage Range
For external power source CoCo-80 uses a wall-mount AC Adapter. The AC Power range is 100Vac – 240Vac.

Maximum Measurement Input Voltage
Maximum Working Input Voltage: 10 V peak. Voltage ratings are given as “working voltage”. They should be read as Vpeak for dynamic applications and as V dc for DC applications.

Max. Input Range without damaging the hardware: 40Vpeak.

If Safety Features are Impaired
If the instrument is used in a manner not specified by the manufacturer, the protection provided by the instrument may be impaired. Before use, inspect the test leads for mechanical damage and replace damaged test leads. If the instrument or its accessories appear to be impaired or not functioning properly, do not use it and send it in for repair.
Quick Start

This Quick Start section is intended to give a brief introduction to the most basic use of the CoCo-80 system. By following the instructions you will learn how to do the following:

1. Install the EDM software to your host PC.
2. Record Time Streams with CoCo-80.
3. Download and view the data on the host PC.

After completing the Quick Start tutorial you should read the following sections for a more comprehensive description of the system.

Install Engineering Data management (EDM) software to PC

To install EDM and related software systems included on the CD, place the installation CD in the CD drive on your PC. The Welcome Screen will automatically open as shown below. If the Welcome Screen does not automatically open, run the Setup.exe file on the root level of the CD by selecting the physical drive with the CD, opening the EDM folder, and double-clicking on Setup.exe.

![Welcome Screen for EDM Installation CD](https://www.go-ci.com)

Figure 3: Welcome Screen for EDM Installation CD.

To launch the EDM installer click **Install EDM Software (version X.X.X.X)** from the EDM Installation screen to launch the Installation Wizard.
Click **Next** to begin the installation process.

Review and accept the license agreement and click **Next**.
To install EDM a valid license key is required. If the default location does not contain your license key, browse for the correct folder. Once the license key has been specified, press **Next**.

![Figure 6: License Key directory page](image)

**Note:** If you do not know the location of your license key or do not have a license key, refer to the section of this manual titled **Where is My License Key**.

Specify the installation directory and press **Next**. The default directory is C:\Program Files\Crystal Instruments\EDM.
If desired, specify preferred location for Data Files, CSA Projects, Arbitrary Signal files, and Limit Collection files. Press **Next** to continue.
Specify Start Menu folder name and press **Next**.

Select your preferences for Shortcuts, Default Units, Default Language, Paper Size, and Multiple Module support. These setting can be changed later in the EDM Settings menu. Press **Next**.
Review the installation setting. Click back if changes are necessary. Click **Next** if all settings are correct. The Installation Wizard will then set up EDM according to the settings.

---

**Figure 10: EDM Default settings**

**Figure 11: Installation summary page**
Click **Finish** to exit the EDM installer.

![Completed installation page](image)

**Figure 12: Completed installation page**

Engineering Data Management (EDM) is PC software used for data management, post signal processing, viewing, reporting, and connecting Crystal Instruments hardware, the PC, and the data storage system. EDM provides connectivity to one or more CoCo or Spider devices. It provides data management tools to search through many tests and records, and view file properties or waveform characteristics. The analysis tools display data in a wide variety of formats and configurations to help identify important signal characteristics using cursors. The report tool documents the hardware configuration or data analysis results in a user formatted document.

EDM has two working modes for use with CoCo:

- **CoCo-80 DSA mode**: access CoCo-80 in its DSA mode, download, and view data files. CSA Editor, a tool for editing CoCo testing projects, will be included in this mode. This manual will cover information on the basic CoCo DSA functions.
CoCo-80 VDC mode: creates a route data collection database, uploads settings to CoCo, downloads data to PC, and performs trending and alarm analysis. There are two versions of VDC modes: personal and enterprise. The personal version allows the user access the database on his local PC. The enterprise version allows multiple users access to the database over a LAN. For more information on VDC mode, check the CoCo VDC Manual.

EDM software is registered to a CoCo device. To activate the EDM software, a valid License Key is required. EDM software uses a License Key file to enable or disable certain functions. License Key files are also used to control the Activation Period and Software Subscription Renew period. Multiple License Keys can be installed in one EDM installation. This allows one instance of EDM to run multiple Crystal Instruments devices.

A typical management page for license keys is shown below:
Software Renew Period: this is the time period that this EDM installation can be upgraded using the currently installed License Key. When the time expires, the EDM software will still be functional but cannot be updated.

Software Activation Period: this is the time period that this EDM installation can be used under this License Key.

Where is My License Key?

Your License Key is a file with extension of *.LIC. There are three ways to obtain your EDM software License Key:

(1) When your EDM Software and CoCo are shipped from Crystal Instruments, we will send out an automated email message providing shipping information, your License Key and the Serial Number of your instrument.

   If you already have an evaluation copy of EDM software installed, you will use the License Key to obtain the additional features of EDM.

(2) If you have not received the automated email message, or do not have your License Key, log into the CI Technical Support Site: http://www.go-ci.com/support.asp using the CoCo serial number and the password provided in the automated message mentioned above, you can then retrieve the License Key from the technical support site:

(3) Call Crystal Instruments Technical Support in the US at (408) 986-8880.
**USB Device Driver**

After the EDM installation is complete, the CoCo can be connected to the PC using any of the connection methods described below. If a USB cable is used as the connection then the USB driver must first be installed. This requires the following steps:

Install the EDM software on the PC.

Install the RNDIS USB driver on the PC.

Connect CoCo to the PC through the provided USB cable. This cable has a mini-USB connection to the CoCo and a standard USB 1.1/2.0 connection to the PC.

Other connection options are possible and are described in the CoCo section of the manual.

For detailed instructions on setting up the USB driver click User Guide and Tutorial on then Welcome Screen, then click Technical Support Documents, and finally open the How To Setup the CoCo USB Driver tutorial.

**EDM Software Update**

After EDM has been installed, you should check for updates to the software that may be available. There are two ways to get update EDM:

4. Log into the Technical Support Site via the Internet, download the EDM SETUP.EXE file to your computer, and install it manually.
5. Request a new installation CD from CI.

**Recording Time Streams with CoCo-80**

Push the power button on CoCo and wait for about 30 seconds until the Welcome screen is displayed. If the CoCo is not charged, connect the power supply to simultaneous power and charge the system.

Use the Up or Down arrow buttons to select one of the CSA project files to run.

In the signal display screen, press F2 (Param.) and select Time Stream Recording Setup to define data streams for recording. To enable the recording for any signal, first use the up/down arrow navigation buttons to move to the signal, then press the Enter button to select or de-select.

Push the Rec./Stop button to record the signals. After a few seconds push the Rec./Stop button again to stop the recording.
Push the **File** button, then the **Files** soft button to review the recorded signals.

**Download Data to the PC**

Connect the CoCo to the PC using the USB cable provided. Note there are two USB ports on the CoCo-80 device. Connect the USB cable to the smaller USB-client connector shown below.

![CoCo to PC USB Connection](image)

Browse for the device driver on the CD and the Windows operating system will automatically install the CoCo-80 USB driver on the PC. If the driver is not automatically installed, refer to the USB Device Driver section of this manual.

Run the EDM software from the host PC.

Click **Search** in EDM to search for CoCo devices that are connected to the PC.

After the EDM finds the CoCo, click **Connect**.

Drag the data file from the CoCo (xxx.atfx) to a local folder.

Right-click on the signal file xxx.atfx in the local folder, and click **View** from the pop-up menu.

EDM will now switch to the View page. Drag the signal ch1 into the empty center area. The waveform that was just recorded will be displayed.

After completing this short Quick Start tutorial, refer to the following sections and review the complete Users Manual for a detailed description of the features and operating instructions.

**Important Notice about the Concept of CSA**

CSA stands for Configurable Signal Analysis. Each CSA is designed to capture a specific type of measurement. As a result, not all types of analysis are present in every CSA. For example, the CSA **Time(4)** only shows and records the time
streams of the input channels and does not allow the use of a trigger, transient capture, or spectral analysis. Features for a specific CSA are defined using CSA Editor, a utility in EDM.
Basic CoCo-80 Operation

This section provides a detailed description of the CoCo-80 device including the user interface, hardware, CSA projects, and peripherals.

CoCo-80 User Interface

The CoCo-80 menu-driven user interface is easy to use and requires little training. Hard buttons on the front panel are used to enter function-specific menus. The buttons are divided into three areas: the navigation buttons include the **power**, **shift**, **ESC**, **enter** and **arrow buttons**; the function buttons include the **Analysis**, **Display**, **Next Trc**, **Setup**, **File**, **View Mode**, **Sensors**, **Recall**, **(User)**, **Rec/Stop**, **Save**, and **Trg On/Off** buttons; the six soft buttons located directly below the display change function depending on the current mode selection.

![Button layout on the CoCo-80 front panel.](image)

Summary of Buttons

The following table gives a brief description of the function of the buttons on the CoCo-80.
<table>
<thead>
<tr>
<th>Button Name</th>
<th>Functions</th>
</tr>
</thead>
</table>
| **Power**   | Power the system on  
Power the system off  
Reset the system (press and hold it for 4 seconds or longer) |
| **SHIFT**   | Shift the functions of the arrow buttons or other buttons |
| **Up arrow**| Move the focus up  
In display window scaling, expand the vertical range  
In display window pan, vertically move the display range up (depending on SHIFT position) |
| **Down arrow**| Move the focus down  
In display window scaling, reduce the vertical range  
In display window pan, vertically move the display range down (depending on SHIFT position) |
| **Left arrow**| Move the focus left  
In display window scaling, reduce the horizontal range  
In display window pan, horizontally move the display range left (depending on SHIFT position) |
| **Right arrow**| Move the focus right  
In display window scaling, increase the horizontal range  
In display window pan, horizontally move the display range right (depending on SHIFT position) |
<p>| <strong>Enter</strong>   | Confirm, accept |
| <strong>Analysis</strong>| Change to analysis screen |
| <strong>Display</strong> | Change to the main signal display screen |
| <strong>Setup</strong>   | Change to the main setup screen |
| <strong>File</strong>    | Change to the main file view screen |</p>
<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rec./Stop</td>
<td>Start or stop the time domain data recording designated by the CSA project.</td>
</tr>
<tr>
<td>Save</td>
<td>Save the signals that are designated by the CSA project.</td>
</tr>
<tr>
<td>Sensors</td>
<td>Open the input channel setup page to configure the sensors or input channels.</td>
</tr>
<tr>
<td>Recall</td>
<td>Recall or review the last saved signals.</td>
</tr>
<tr>
<td>Next Trc</td>
<td>Switch to the next display trace.</td>
</tr>
<tr>
<td>View Mode</td>
<td>Open the View mode menu to set up the view mode for the active trace.</td>
</tr>
<tr>
<td>Trg On/Off</td>
<td>Turn trigger on or off. When trigger is OFF, it runs in “free run” mode.</td>
</tr>
<tr>
<td>(User)</td>
<td>This button will lead the system to a user previously set CSA and execute it.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1~F6 function buttons</td>
<td>Context dependent function soft buttons</td>
</tr>
</tbody>
</table>

**Table 1: CoCo buttons and common functions**

**Startup**
Press the **Power** button to power on the unit. The initialization screen shows the startup progress. When the startup sequence is complete the Welcome Screen is shown.

**Power off**
To power off the unit, press the **Power** button and then select **Turn Off** and press OK. The Cancel soft button returns to the previous menu without powering off the unit. Lock keypad function can be selected instead of Power Off. Stand by LAN function will turn off the LED display but keep CoCo running.

**Arrow Buttons**
The arrow buttons are used to move the focus from one field to another on the display. By moving the focus you can select different fields to enter parameters, select other screens, and enter text. They are also used to zoom in and pan.
around a trace. When cursors are enabled, arrow buttons are used to move the
cursor positions. In the trigger setup window, the arrow buttons can be used to
move the threshold and trigger delay.

**Enter Button**
The **Enter** button is used to accept an entry or select an item on the display. In
general to select an item use the arrow buttons to move the focus to the item and
then press the **Enter** button to select the item.

**Shift Button**
The **Shift** button serves multiple functions depending on the context. In the
signal display window, the **F4(Zoom)** soft button zooms in/out or moves the
display. The **Shift** button toggles between zoom and move. **Zoom** changes the
size of the plot and **move** changes the position of the view.

In **Trace and Window Settings**, the **Shift** button toggles between the top and
bottom traces in a two trace window.

**Escape Button**
The **ESC** button is used to move back to previous screens, or cancel the current
action. As the screens are changed using the function or soft buttons, the CoCo-
80 remembers the previous screens so they can easily be recalled.

**Soft Buttons**
The **F1 – F6** soft key functions change depending on which screen is currently
shown. Some soft buttons open new screens that include additional soft buttons.

![Figure 18: CoCo soft keys](image)

**Text and Number Keypad**
Several screens require entering text using the keypad. When the text keypad is
displayed, use the arrow buttons to move the focus to a letter or number and press
the **Enter** button to select the character. When the text entry is completed, press
the **F6(OK)** soft button.
- **Upper/Lower** toggles the font to upper or lower case font.
- **Clear** deletes all text from the text field.
- **BackSpace** deletes the character to the left of the cursor.
- **Space** adds a space.
- **Cancel** closes the screen without changing the text.
- **OK** accepts the text and closes the screen.

**Note:** It may be more convenient to use the 12 hard buttons to enter the number or letters. For example, the Display button can be used to enter the number 2 or the letter A, B or C. Pressing the button quickly will advance through the options. It is just like texting messages with most cell phone. Pressing the display will cycle through 2, a, b, c, and begin again at 2.

**Status Bar**

The Status Bar indicates the status of the system.
Navigation indicates the name of the screen or provides information about the analysis such as sampling rate.

Volume indicates the volume level for the internal speaker.

Power indicates battery or line power.

Battery status indicates the state of charge.

Indicates whether a connection between the CoCo and a computer exists. A green check, as show, indicates a physical connection, a red x indicates connection problems.

System time displays the time (defined in the Setup screen).

Other statuses, such as sampling rate, number of averaged frames in spectral processing, and number of frames acquired will be displayed according to the running CSA.

**Welcome Screen**

The Welcome Screen is shown after the system has completed the startup sequence. It shows the 4 most recent CSA projects at the top and other functions at the bottom. It can be used to verify the date and time, network connection settings, select a CSA project, and run the project.

![Welcome Screen](image)

Figure 22: Welcome screen is shown on startup.

**Analysis Button**

The Analysis Button brings up the Configurable Signal Analysis (CSA) groups.
This screen shows several categories of applications. These categories mostly match with the template that the CSA uses when it is created with a few exceptions: octave analysis and sound level meter applications are grouped in Acoustic Analysis group. Any CSA with limiting test are grouped in Limit Test group.

After entering one of the application groups, a list of the CSA projects is displayed in a menu on the left, with information about each project to the right. Use the Up and Down arrow buttons to select a project and read the description, maximum sampling rate, when it was last modified, and publisher information on the right. When additional CSA projects are loaded from a PC to the CoCo-80 they will appear on the menu. After selecting one CSA project from the menu press the F6 (Run) soft button to load and run the CSA project.
**Save As...** saves the current CSA project with a different name. This can be used to change project parameters and save the new project without overwriting the original project.

**Delete** removes the CSA project from the CoCo-80 flash memory. The CSA project can be reloaded from the PC if it is accidentally deleted.

**Move to** lets you move the CSA project file to another group.

**Cancel** returns to the previous screen

**Run** loads the selected project and starts the display. The Enter button also loads and starts the selected project.

**Display Button**

The Display Button brings up the main Signal Display Window. Pressing the Display button and Enter will always lead to displaying the current active window. This is the most frequently used window in this instrument.

![Display screen showing a window with one trace.](image)

A signal display window can have either one or two traces. The software allows three types of signal display windows: A window with one trace; a window with top and bottom traces, a window with a 3D waterfall trace. Some CSAs also have other displays available, such as bar graphs and color spectrographs. The picture below shows a window with two traces.
A trace is defined as a display area with an axis that can show multiple signals of the same dimension such as time or frequency. Only the signals with the same engineering units in X and Y axis can be overlaid.

The traces are periodically updated when the Display is in Run mode. To stop the trace updating press the **F6 (Hold)** soft button. Note that the trace updating display is independent of the Record operation. This means that while traces are updated on the display they are not recorded to memory until the Rec./Stop button is pressed.
A trace typically consists of five objects:

1. The signal label on the left side (displayed as APS(ch1) in this example)
2. The center display area (the area highlighted in red)
3. The view mode (displayed as dB((V)^2(RMS)) in this example)
4. The vertical Y-scale range on the right
5. The horizontal X-Scale on the bottom

The **Arrow** keys move the selection box (shown in red above) from one object to another. Once one of the objects is highlighted, pressing **Enter** button will guide to an operation to set the property of that object. Below is a table describing the property that is adjusted when **Enter** is applied to a certain area on the screen:
<table>
<thead>
<tr>
<th>Highlight Area</th>
<th>After pressing Enter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highlight the Y Label area then press the Enter button. CoCo will show <strong>Change Signals</strong> in Trace window.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highlight the center plot display area then press <strong>Enter</strong>. CoCo will change to ZOOM mode for 5 seconds. Use four <strong>Arrow</strong> buttons to scale the window.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highlight the X label area then press the Enter button. CoCo will change to X scaling mode for a 5 seconds. Use four <strong>Arrow</strong> buttons to scale the X axis.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highlight the Y display unit then press <strong>Enter</strong>. CoCo will display the available view modes. Highlight one using the <strong>Arrow</strong> keys, then press <strong>Enter</strong> to select it.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highlight the Y grid area then press <strong>Enter</strong>. CoCo will change to Y scaling mode for 5 seconds. Use the four <strong>Arrow</strong> buttons to scale the Y axis.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Trace viewing functions

Pressing **Display** again while viewing a live signal window will bring up a menu to access to several trace functions.
**Display Preferences** contains the settings for trace defaults, shown below. When the blue focus is on each item, press **Enter** to choose display preferences options from the dropdown menu. Finally, press **Apply** to save the changes and go back to the previous screen, or press **Cancel** to go back to the previous screen without saving any changes.

**Auto Scale X-Axis** returns to auto scale status on the X-axis.

**Set Exact X-Axis** range allows CoCo to display the specific ranges on the X-axis.

**Set Exact Y-Axis** range allows CoCo to display the specific ranges on the Y-axis.
Signal Display Soft Buttons

Traces (F1)  
Pressing **F1 (Traces)** opens the **Window and Trace Menu**. This menu lists the names of the existing windows in the display and is used to change the windows and signals in the display. The menu lists the defined windows at the top of the menu. The display can be changed from one window to another by selecting a different window from the menu and pressing **Enter**. Multiple windows can be created to provide a flexible display format.

![Figure 31. Window and Trace Menu.](image)

Selecting **Trace and Window Settings** opens the Trace and Window Setting screen. This screen is used to add new windows and define which signals will be included in each trace.

After selecting **Trace and Window Setting**, a new window can be created by pressing **F1 (Add Window)**. Choose from a single 2D trace, two 2D traces, one 3D waterfall trace, or one color spectrogram.

![Figure 32: Options for types of new windows](image)

After selecting the window type, signals need to be enabled to be displayed in this window. To select a signal press the **Enter** button to check it. Only signals that
are defined in the CSA as display candidates will be visible and available to be added to the trace. This feature is designed to simplify the user interface and optimize the CoCo-80 computation resources. If a signal is not available for display then the CSA must be edited before it can be added.

After the first signal is selected, only signals of the same type will show in the list. Additional signals of the same type can be selected to overlay them on a single trace.

To set up a window with two traces, first select **Add a Window with two Traces**. The following screen will be displayed:

![Edit window screen](image)

Figure 33. Edit window screen is used to add/delete window and add signals to each trace.

In this screen the top and bottom trace can be defined by selecting appropriate signals in the same way as you set up the one trace window. To switch between top and bottom traces within the window, press **Shift**.

**View Mode** changes the mode of the current display. The signals can be displayed in a graphic plot or as a text value. The text value can display different quantities such as RMS, Peak, and Average value of the signal. For graphic plots, the view mode also selects the ordinate scale type (linear, logarithmic, or dB). Depending on the type of plot (time stream, APS, etc), different selections will be available. The view mode can also be changed in the Display window, by pressing the **F1 (Traces)** soft button and selecting **Select View Mode for Current Trace**.
Other soft buttons under the Trace and Window settings control the windows in the current display. **Add Window** creates a new window in the Window List. Windows are named sequentially as Window1, Window2, etc. **Delete Window** removed the highlighted window from the Window List. **Clear Signals** removes all signals from the highlighted trace. **Select All Signals** adds all signals to the highlighted trace. **Cancel** returns to the previous screen without changing the trace definitions. **OK** saves the changes to the trace definitions and returns to the previous screen.

**Param (F2)**

**Param** opens the Parameter Settings Menu. This menu sets parameters for the sampling rate, input and output channels, triggering, spectral saving, and time stream recording.

**Param -> Sampling Rate (fs)/Freq. Range(fa)** is used to set the sampling rate or frequency range for data acquisition. Sampling rate and frequency are related, the frequency range is approximately 45% of the sampling rate. Use the **Up** and **Down** arrow buttons to select from the scroll menu and press **Enter** to accept the setting. Frequency range is a global setting that applies any loaded CSA.
**Param -> Analysis Parameters** is used to change parameters that are defined in the CSA project. These parameters depend on the definition of the CSA project but may include block size/line, window type, average mode, average number, weighting type, etc. Refer to the CSA project description in Section 4 for more details. Analysis Parameters are dependent on the selected CSA. Different set of CSAs may show different Analysis Parameters.

![Analysis Parameters Setup Screen for A CSA Project.](image)

**Param -> Input Channels** brings up the Sensor and Channel Setting window. It displays the peak magnitude of each channel over a small averaging time period. The vertical scaling of the bars is logarithmic, which helps the user see both large and small signals.

Thanks to the high-dynamic technology implemented in the CoCo, as long as the signals are within the full range, the measurement will be accurate. However if the signals are above the full range, overload will occur and the instrument will flash to warn the user.
Select **F1 (Edit Table)** to bring up the **Input Channel Table**. This is used to set the sensitivity, input mode, and label for the hardware input channels. To edit these parameters use the **Arrow** buttons to select the parameter and press **Enter**. Input channel settings are global settings that apply any loaded CSA.

**Input Channel Table Settings**

**Sensitivity** is used to set the physical quantity, units, and sensitivity of the input channel. Use the arrow buttons to select the parameter and press **Enter** to select it. The parameters can be applied to all channels using the soft button **Apply to all Ch.**
Measurement Quantity defines the quantity such as acceleration, velocity, displacement, force, voltage, etc.

Sensor Engineering Units defines the engineering units such as m/s², cm/s², g, etc. for the input channel.

Sensor Sensitivity defines the sensitivity in millivolts/engineering unit defined in the unit menu. This selection opens a numeric keypad to enter the sensitivity value. Press the OK soft button to accept the value.

dB Reference defines the dB reference value for certain measurement quantities.

Select Integration/Differentiation gives the options of No Integration/Differentiation, Integration/Differentiation, or Double Integration/Differentiation when the measurement quantity is acceleration, velocity, or displacement.

When the Physical Quantity is set as Acceleration a built-in integration or double-integration module may be used to generate readings in velocity or displacement. When the Physical Quantity is selected as Velocity, integration to displacement or differentiate to acceleration modules can be enabled. Note that the algorithms for integration are implemented in the digital domain and include a high-pass filter and DC removal routines.
The instrument can automatically detect the status of IEPE sensor connections. If the IEPE type of sensor was not connected correctly, the input channel status will display **IEPE**.

In the picture above, channel 1, 2, and 3 are enabled with IEPE input mode, channel 4 is not. Since channel 1 is connected with the IEPE sensors, green letters “**IEPE**” are shown. Channel 2 and 3 are not connected to an IEPE sensor therefore “**IEPE**” is displayed.

**Input Mode** is used to set the type of sensor being connected. The choices are AC-Differential, AC-Single Ended, DC-Differential, DC-Dingle Ended, and IEPE.
**High-Pass Filter** is used to define the cutoff frequency of a high-pass filter. The range is from 0.1 Hz to current frequency range.

**Label** is used to change the name of the signal. Use the alphanumeric keypad to enter a label name and press the **OK** soft button to accept it.

**Param -> Output Channel** is used to define the waveform for the output channel. Use the **Up/Down** arrow buttons to select from Sine, Triangle, Square, White Noise, Pink Noise, DC, Chirp, Swept Sine or Arbitrary Signal. Selecting None turns off the output channel. When a signal type has been selected, pressing **Right** will shift the selection cursor to set the parameters for that type of output.

![Output Channel screen.](image)

For each waveform the parameter settings must also be entered such as range, frequency and amplitude. Output Channel is a global setting that applies any loaded CSA. Once the parameters have been set, the output must be turned on by pressing **F4 (Enable)**. The output can be turned off by pressing **F4 (Disable)**.

When the **Arb waveform** is selected, an arbitrary waveform file must be selected to output. This file must be uploaded to the CoCo-80 through EDM before it can be used.
In the arbitrary waveform setup, the duration is fixed by the number of points in the arbitrary data file and the sampling rate in use. The Quiet Zone is the time with “zero” output between two arbitrary waveform pulses. The Peak Output Level is the normalized maximum volt for the output waveform. Regardless of the value in the arbitrary file, it is always normalized to this peak level volt.

**Param -> Acquisition Mode** is used to configure the trigger and how the data blocks are captured from the conditioned time streams into the signal analyzer phase. The selections are:

1. Free Run
2. Continuous after Trigger
3. Single Shot without Trigger
4. Single Shot with Trigger
5. Manual-arm Trigger
6. Auto-arm Trigger

It is important to note that the Acquisition Mode is designed for signal analysis functions only, such as spectrum measurements. The data conditioning process is not affected by the Acquisition Mode. For example data recording will continue uninterrupted regardless of the Acquisition Mode. Acquisition Mode setting is dependent on the selected CSA.

**Param -> Schedule Setup** is used to configure automated test schedules.
The test schedule automatically controls the test duration and imitates human operation. Multiple testing schedules can be developed and one is executed at a time. A testing schedule event can include the following events: Loop/End-Loop, Run Duration, Hold, Limit Check on, Limit Check off, Start Recording, Stop Recording, Save Signals, Turn Signal Source On, Turn Signal Source Off, Reset Average, Set All Input Mode, Activate/Deactivate Timer to Save/Stop Saving, and Wait for One Time.

Activating the testing schedule requires an extra step. This is designed to ensure the test schedule does not start inadvertently. To activate the testing schedule go to the main signal display window and press the **Display** button for 3 seconds, then release. This will activate the test schedule. After the test schedule is activated, all the buttons, except the power button, F5 and F6, will be deactivated because the test is in the automatic mode.

To exit the automated schedule, press **Exit** (F6). To redo the schedule, press **Redo** (F5).

Using schedule allows the instrument to divide the total measurement into multiple files, making it easier to retrieve and analyze. The picture above shows a typical schedule with loop/end loop functions. It allows the instrument to run on standby for 1 minute, record for 1 min, then save the spectral data. This is repeated 10 times.
When the schedule is activated, the schedule status will be displayed during the run time.

![Schedule Display](image)

Figure 46: Display as a schedule of operations is performed

Use the following formula to calculate the total time duration that you can record:

\[
Total \text{ Installed Flash Memory in Bytes} = (\text{Channels Enabled}) \times (\text{Recording Time in Seconds}) \\
\times (\text{Sampling Rate}) \times (8 \text{ bytes}) \times (1.2)
\]

Or

\[
\text{Recording Time in Seconds} = \frac{\text{Total Memory in Bytes}}{(\text{Channels Enabled}) \times (\text{Sampling Rate}) \times (8 \text{ bytes}) \times (1.2)}
\]

For example if 6 channels are enabled and the sampling rate is 100 Hz with 4GB memory installed:

\[
\text{Recording Time in Seconds} = \frac{4\text{GB}}{(6\times100\times8\times1.2)} = \frac{4\times1024\times1024\times1024}{(6\times100\times8\times1.2)} = 745654 \text{ sec} (= 207 \text{ hours})
\]

**Param -> Display Preferences** allows making changes to display preferences. When the blue focus is on each item, press **Enter** to choose display preferences options from the dropdown menu. Finally, press **Apply** to save the changes and go back to the previous screen, or press **Cancel** to go back to the previous screen without saving any changes.
**Param -> Time Stream Recording Setup** defines which time streams will be recorded to memory when the **Rec./Stop** button is pressed. To add a stream to the record list, select it in the Signal List using the **Up** and **Down** buttons and press **Enter**. Note that adding more signals to the Record List increases the file size of the recording and reduces the recording duration. Only streams that are of interest should be recorded to conserve memory and maximize recording time. **Time Stream Recording Setup** is dependent on the selected CSA. Note that only signals that are identified as **Record Candidates** in the CSA file will be visible and can be recorded. This feature is designed to simplify the CoCo-80 user interface and optimize the device computation resources.

**Param -> Spectral Save Setup** defines which signals will be recorded to memory when the **Save** button is pressed. To add a signal to the record list,
select it in the Signal List using the Up and Down buttons and press **Enter. Spectral Save Setup** is dependent on the selected CSA. Note that only signals that are identified as **Save Candidates** in the CSA file will be visible and can be saved. This feature is designed to simplify the CoCo-80 user interface and optimize the device computation resources.

![Spectral Save Setup](image)

**Figure 49: Select Spectral data to be saved**

**Param -> Limit Alarm Setup** defines the actions to be taken when testing limits are exceeded. This menu item will only be shown when the CSA project contains limit checking. This menu entry is not available unless specified in a custom CSA.

![Limit Alarm Setup](image)

**Figure 50: Limit test alarm settings**
Limit Check Alarm Events include Beep, Screen Flashing, Event Log into Testing Log, Send Message to Host PC, Save Signals.

Control (F3)

Control -&gt; Restart is used to reset the relative time base of the time streams and also reset the averaging and triggering if these features are used in the current CSA project. In Some CSAs, where Restart is the only control option, F4 will display Restart rather than Control. Restart is used to control the running status without re-initializing the project and test.

Control -&gt; Trigger On is used to setup trigger or turn on the preset trigger.

Control -&gt; Shock Setup is used to enter the Shock Control Setup mode. In this mode, a shock test will be performed.

Control -&gt; Scanner is used to activate the barcode scanner function. The user info and device info contained in a barcode can be read into the CoCo.

Auto/Zoom/Move (F4)

Auto-Scale/ZOOM/Move controls the vertical scaling of the trace. Auto applies an automatic vertical scaling continuously adjusts the axis to keep the signal near full scale. ZOOM scale turns off the automatic scaling and uses the current scale regardless of the magnitude of the signals. When in the ZOOM scaling mode, the four arrow buttons are used for the purpose of reducing or expanding. Pressing the SHIFT button will switch from ZOOM to Move, or Move to ZOOM. When in the Move mode, the four arrow buttons are used for the purpose of repositioning the window. The following diagram further explains the changes in the three different mode of using the navigation buttons:
Figure 53. Trace navigation buttons.

Cursor (F5)

**Cursor** adds a vertical cursor to the trace. Use the **Right** and **Left** arrow keys to move the cursor. The signal values are listed to the right for all signals in a trace. Press the **Cursor** button again to remove the cursor from the trace.

![Cursor Setup Menu](image)

Figure 54. Cursors can be added to a trace.

After the cursor is added, a menu item is added to the Cursor Setup menu, **Move Cursor Display Location**. If you select it, you will be able to move around the cursor display text using the four arrow buttons. Press **Enter** to fix the location of the display.

![Cursor Setup Menu](image)

Figure 55. Cursor setup

To add a peak marker to the display, move a cursor near a peak and press the up arrow button. The any signal peaks within ±10% of the cursor location will be marked.
Figure 56. Peak Detector

To calculate RMS within a frequency band for frequency-domain signals, select the **Calculate RMS** menu item:

Figure 57. Cursor setup

The RMS value will be displayed in the same unit as Y label units. This value is the energy between the two vertical cursors.

Figure 58. Multiple cursors display
Calculate THD option will calculate the Total Harmonic Distortion of auto-power spectrum signals between the two vertical cursors. The CoCo looks for a peak near the left cursor to use as the primary frequency.

![Figure 59: THD function using a cursor](image)

When displaying Frequency Response signals, there is a Calculate Damping feature. This will search between two vertical cursors to find the resonant frequency and damping factor of a structural response signal.

![Figure 60: Damping calculation using cursors](image)
In time-domain signals, the calculate RMS feature is available to calculate the root-mean-square value of the signal duration specified by two vertical cursors. In addition, the damping value of a periodic decaying signal can be calculated. To do this, select Calculate Damping, and place the two cursors on the peaks of successive periods.

Run/Hold (F6)

**Run/Hold** controls the display update and the signal analysis process. When the device is in **Run** mode the display updates the traces with the signals as fast as possible. When the device is in **Hold** mode the display stops updating. Note
that **Run/Hold** is independent of **Record/Stop**. This means that when in **Run** mode signals are not recorded to memory until the **Rec./Stop** button is pressed. The record status is indicated by the red record icon blinking at the top of the screen during recording. It is important for you to understand the difference between **Run/Hold** and **Record/Stop** so that operator errors are not made when recording signals.

When in **Hold** mode, the signal analyzer will be held. Processing such as spectral analysis will be frozen.

**Display Window Types**

**Bode Plot**

The term Bode Plot is borrowed from the field of control theory, referring to a plot of magnitude and phase angle between the input and output verses frequency of a control system. Many in the rotating machine vibration industry have adopted this term to describe the steady-state vibration response amplitude and phase angle versus rotational speed (RPM). It turns out that the Bode Plot is the best way to describe order tracks with phase. Bode plots are typically used for transient analysis in both start-up and coast-down conditions. A Bode plot can help to identify the resonance speed of a rotor or examine the rotor dynamics on an order basis.

In the CoCo system, after the order tracks are acquired together with their phase information then the Bode Plot can show one or multiple tracks.

**Nyquist Plot**

The Nyquist Plot shows real and imaginary values of a Frequency Response signal. The signal is plotted parametrically in frequency, with a red line showing the real and imaginary values over the frequency range. Real values are plotted in the horizontal axis and imaginary values in the vertical axis.
While viewing this plot, pressing F5 will add a cursor as a small green ‘+'. Press the Left and Right arrow keys to move the cursor. The current frequency, real and imaginary values, and the magnitude and phase are shown on the right.

**Setup Button**

The Setup button changes the screen to the Main Setup screen. Main setup includes both measurement settings and system settings. Use the arrow buttons to select one of the setting icons and press the Enter button to select it. Some systems settings are under the Other. The system settings are described below.

**CSA Application Group** is the equivalent to pressing Analysis button.

**Self Test** allows running a self test for the hardware without using external meter. A built-in precision signal source is used to check whether the input
channels are in the reasonable range. If the circuitry of any channel is damaged or goes out of range, the **Self Test** will display the error. **Self Test** does not change or replace the last calibration results.

**Testing Log** records activities related to the tests. A sample of the testing log is shown below.

![Testing Log View](image)

**Memory** displays the status of the CoCo-80 memory. This includes local memory used by the CoCo-80 software and the flash memory used to store recorded data. This display can be used to monitor the remaining flash memory during field operations. When the flash memory is full the data must be downloaded to the PC and removed from the CoCo-80 before more data can be recorded.

![Memory and DSP CPU usage](image)
**Date/Time** sets the current date and time so a timestamp can be included as a file attribute with the data files.

![Date/Time Settings](image)

**Connections** displays the status of the Ethernet, USB, or Wireless connections. The **IP Setup** soft button configures the connection to use a fixed IP address or a DHCP (dynamic IP) connection.

![CoCo Connection Configuration](image)

**Storage Card** displays the file contents on the SD card. Press **Refresh** to update the file structure. Press **View Files** to operate on selected files.
Figure 69: File browsing of the SD card

**Power** indicates the status of the power including the **Remaining Capacity** of the battery. The **Advanced** soft button configures the power settings to optimize the battery life for specific conditions including **Automatic Mode** which maximizes the battery life by automatically turning off the LCD and the backlight and Ethernet. **Maximum Active Mode** keeps all components on but uses the maximum power consumption. The **Reset Value** resets the total time on battery.

Figure 70. Power Status Screen.

**Change Password** is used to change the VDC password (if available), to modify the access control password, and to modify the access control. See CoCo VDC manual for more information of changing the VDC password. When access control is enabled, the access password is required to use certain functions. This is to protect the privacy of measurement.
F2 (Update) allows the CoCo to check for new software components on the Crystal Instruments server and conduct online software updates. The CoCo must be connected to the Internet using Ethernet when an on-line update is performed.

F3 (About) displays hardware and software version information, software subscription period, and calibration status.
Figure 73. CoCo Hardware and Software Information

The **F1 (Soft. Options)** button will display all CoCo options and indicated which are installed.

Figure 74. Software Options.

The **F1 (Check Options)** button will check the CI Server for available software options that can be installed. Press **F2 (Page Down)** to view more software options.

**F4 (Help)** displays the help document on the CoCo. Only basic operations are covered. For a more complete resource refer to the CoCo Basic or Advanced DSA Manual.
Figure 75. CoCo DSA Online Help

**F5 (Other) -> Start Page** sets how the CoCo starts up. CoCo can start in DSA or VDC mode directly, or can wait for user’s selection.

Figure 76. CoCo Start Page Setup

**F5 (Other) -> User** shows the information recorded for the user of the hardware including Name, company, address, telephone and Email and appends the information as an attribute to all data files. This information can be edited by selecting it with the Arrow buttons and pressing Enter.
**F5 (Other) -> Digit Notation** is used to change the format for numbers displayed on the CoCo-80. The options are Floating Point, Scientific or Engineering notation.

**F5 (Other) -> Theme** changes the display from black to white background. Animated view makes the screen update smoothly.
**F5 (Other) -> Test Note** allows entering a note to a test or scanning to enter the test note.

**F5 (Other) -> System Calibration** is used to calibrate the CoCo system. The CoCo loads factory calibration data during start-up, eliminating the need for daily calibration checks. Although the CoCo does not require daily field calibration, CI recommends an annual calibration and performance verification by a local CI service center.

System Calibration software is under **Setup/Other/System Calibration** category. CoCo will display steps to perform a system self calibration. Follow the instruction on the CoCo to proceed.
The CoCo will follow 10 steps to complete a self-calibration.

1. **Introduction**
2. **Calibrate the output offset (10 V Range)**
3. Calibrate the output offset (0.1 V Range)
4. Calibrate the output gain error (10 V Range)
5. Calibrate the output gain error (0.1 V Range)
6. Calibrate all the input channels automatically
7. Validate calibration offset result
8. Validate calibration gain result
9. Meter Information
10. Calibration Report

**F5 (Other) -> Audio** allows changing the audio feedback settings including keypad, power button and alarm sounds. The speaker volume and microphone level can also be changed. Voice annotation is controlled through Audio setup as well.

![Audio Settings including Voice Annotation](image)

Among these settings, the **Use microphone to record the voice annotation** and **Use headphone to listen to any input channel** are advanced audio functions, which must be purchased as a software option.

**F6 (VDC)** switches to the Vibration Data Collector (VDC) mode. This is a software option that must be installed on the CoCo.

**File Button**

The File button displays a list of all the data files saved and recorded to the CoCo memory. The files are listed with their creation time and total size. The overall capacity, used space, and free space are shown at the top of the window.

Use the **Up** and **Down** arrow keys to scroll through the list. The **Left** and **Right** arrow keys will move between pages. One or multiple files can be selected by
highlighting them and pressing **Enter**. Some of the file operations, available through the soft keys on the bottom of the display, will work on all the selected files at once.

![File display](image)

**Figure 84. File display**

**Rename/Delete** → **Delete Newest** deletes the currently selected file and all newer files from the flash memory. For example if there are 4 files in order in the list, File4, File3, File2 and File1 where File4 the newest, highlighting File2 and select **Delete Newest** will remove File4, File3, and File2.

**Rename/Delete** → **Delete All** will delete all files from the flash memory at once.

**SD Card** → **Copy to SD Card** copies the selected data files to the SD memory card.

**SD Card** → **Copy All Files to SD Card** copies all the data files to the SD card.

**SD Card** → **View SD Card** shows data files stored on the SD card. The SD card file explorer, shown in *Error! Reference source not found.* shows the directory structure on the left and the files on the right. Clicking **F2 (View Files)** will list the files in the currently selected folder. The review options for these files are the same as those for files stored on the CoCo internal memory.

**Recalled Files** shows a list of all currently recalled signals. Recalled signals will show up on traces in the regular live signal display mode of the CoCo. This is useful to see recorded files along with live signals.

**View Files** shows a summary of the currently highlighted data file. The **Text/Plot** soft button toggles between a text summary of the signal and a simple graphic preview.
A time waveform signal can be viewed in more detail by pressing **F6 (View)**. This view shows a plot of the entire signal on top and of a zoomed in portion on the bottom. The zoom limits of the bottom display are determined by the two cursors on the top display.

Another way to view the full signal is to **Recall** it, which adds it to any of the currently defined live signal display windows. To recall a signal, press the **F3 (Recall)** button:
Figure 87: Recalling data files

A signal can be recalled into an existing trace or a new trace. Recalling into an existing trace will plot this signal over the other signals in that trace.

The signal can also be played back through the output channel of the CoCo. To do this, press **F5 (Playback)**, and then press **F1 (Start Output)**. All annotations attached to this signal will also be displayed in this view.

Figure 88: List of voice annotations associated with the selected file

**Rec./Stop Button**

Pressing **Rec./Stop** will start or end a time stream recording. The CoCo will function similar to a tape recorder, recording all data from the selected inputs continuously until **Rec./Stop** is pressed again or there is no remaining memory. Recording files are named RECxxxx.
**Time Stream Recording Setup** from the F2 (Param.) menu specifies which channels are recorded and where they are saved.

Time stream data can be uploaded to a PC with EDM for further viewing and analysis of the recordings.

**Save Button**

The Save button is used to save block signals to memory. These include transient time signals and spectra signals, which, unlike time stream data, are a snapshot of a single block of data at the time the Save button is pressed. This can be used to capture averaged spectra or transient events at any time. Block and spectral data are saved by default as SIGxxxx.

The Spectral Save Setup menu in F2 (Param.) contains settings for which blocks are saved and where they are saved.

When the CoCo-80 is connected to a PC, the saved block signals can be downloaded using the EDM software.

**Next Trc (Trace) Button**

The Next Trace button is used to switch to the next trace if multiple traces are available during the test. For example, the current test has the first trace displaying the time signal, the second trace displaying the block signal, and the third trace displaying the spectral signal. If the CoCo is displaying the time signal, pressing Next Trace will display the block signal. Pressing Next Trace again display the spectral signal.

**View Mode Button**

The View Mode button is used to switch among various view modes. Current available view modes include signal plot, current value, peak value, peak-peak value, maximum value, minimum value, averaged value. This function is only effective when signals are displayed.

**(User) Button**

The (User) button can be set as a shortcut to a specific CSA. When CoCo is conducting a test, press and hold this button for 3 seconds to enable it. When in a different CSA, pressing (User) will switch directly to the preset CSA.

**Recall Button**

The Recall button is used to recall signals. The saved signal can be recalled to a new window or a current window with the same type of signals.
**Trg (Trigger) On/Off Button**

The **Trg On/Off** button is used to turn on/off trigger. It is a shortcut to arm the trigger instead of going to acquisition mode to arm the trigger. See the acquisition mode section for more information about configuring the trigger.

**Sensor Button**

The **Sensor** button displays the channel input status. Pressing **F1 (Edit Table)** is used to access the input channel setup. This can also be accessed from **F2 (Param.) -> Input Channels** settings.

The input channels table is used to set the sensitivity, input mode, and label for the hardware input channels. To edit these parameters use the arrow buttons to select the parameter and press **Enter**. When the **Input Channels** menu item is selected, the channel status screen will be shown. It displays the peak magnitude of each channel over a certain period of time. The vertical scaling of the bars is logarithmic. The log scaling allows for viewing of both large and small signals.

Thanks to the high-dynamic technology implemented in the CoCo, as long as the signals are within the full range, the measurement will be accurate. However if the signals are above the full range, overload will occur and the instrument will flash to warn the user.

![Sensor and Channel Setting](image)

**Figure 89: Input Channel and Sensor Setup**

The sensor table is used to set the physical quantity, units, and sensitivity of the input channel. Use the arrow buttons to select the parameter and press **Enter** to select it. The parameters can be applied to all channels pressing **F1 (Apply All)**. The input channel sensors and sensitivity all can be set up in either EDM or in the CoCo.
Sensitivity is defined in millivolts per engineering unit. The Engineering Unit is dependent on the Measurement Quantity selected. This selection opens a numeric keypad to enter the sensitivity value. Press F6 (OK) to accept the value.

When the Physical Quantity is set to Acceleration, a built-in integration or double-integration module can be applied to generate readings in velocity or displacement, respectively. When the Physical Quantity is selected as Velocity, Integration to Displacement and Differentiate to Acceleration are available. Notice that the algorithms for integration are implemented in the digital domain. They also included a high-pass filter and DC removal routines.
**Hi-Pass Fltr** sets the cutoff frequency of high-pass filter for each individual channel. This is a very important parameter especially when accelerometer is used at the front-end and velocity or displacement is set as measurement quantities.

**Input Mode** is used to change the input mode. The choices are AC-Differential, AC-Single Ended, DC-Differential, DC-Dingle Ended and IEPE.

The instrument can automatically detect the status of IEPE sensor connection. If the IEPE sensor is not connected correctly, the input channel status will alert the user.

In the picture above, channel 1 and 2 have IEPE enabled, channel 3 and 4 do not. Since channel 1 has an IEPE sensor connect, **IEPE** shown is displayed below the
channel in green letters. Channel 2 is not connected to an IEPE sensor therefore **IEPE** is displayed in red letters with a strikethrough.

**Label** is used to change the name of the signal. Use the alphanumeric keypad to enter a label name and press the OK soft button to accept it.

**CoCo-80 Startup and Shutdown**

This section describes powering the CoCo on and off, locking the keypad, and resetting the CoCo-80.

**Power on and off the CoCo-80**

The **Power** button is located in the lower-left corner of the CoCo. The very first time the CoCo-80 is used, it is necessary to set the clock time. All the data acquired and stored will include the time it was recorded as a file attribute with a clock time accuracy of seconds.

There are two LEDs on the front panel. The left LED is an indicator for the system power. When the system is turned on, it will be red. The LED on the right is the indicator for external power charging. When the CoCo is being charged, it will be lit in red. When the system is fully charged and still connected to the external DC power, it will be lit in green.

![Figure 94: Two LEDs showing power and recharge status.](image)

**System Reset**

In the rare event of a system lock up the **Power** button may not respond. To restore the unit you can reset the system in one of two ways.

**Reset the system using the Power Button**

The system can be reset by pressing the power button for more than 4 seconds which will force the system to shut down. After the system is shut down, it can be rebooted by pressing the power button again.
Reset the system by Pushing the Reset Pin
The system can also be reset using the recessed Reset button inserting a pin or paper clip through the reset hole. The Reset pin hole is shown below.

![CoCo side panel with Reset button](image)

Figure 95: CoCo side panel where the Reset button is located

CoCo-80 Software Disaster Recovery through EDM
In the event that the CoCo-80 application software programs are completely corrupted due to an unknown reason, EDM can be used to restore the CoCo-80 back to its original state when via USB.

To perform a full recovery open Global Settings through the CoCo menu and select CoCo Recovery. Follow the instructions there to complete the restore process.

**Important:** This method should be used as a last resort. All custom CSA’s and any data stored on the CoCo will be lost.

Keypad Lock
To avoid unintentional operations the keypad can be locked by pressing the **Power** button and selecting **Lock Keypad** from the menu.

![CoCo-80 keypad menu](image)

Figure 96. Select to Lock Keypad
Hardware

CoCo-80 Input Connections

This section describes the CoCo-80 input connections and the related circuit design including a description of AC/DC-Single End, AC/DC-Differential, and IEPE input modes.

System Calibration

The CoCo loads factory calibration data during start-up, eliminating the need for daily calibration checks. Although the CoCo does not require daily field calibration, CI recommends an annual calibration and performance verification by local CI service centers.

To execute the System Calibration, first press the Setup hard button, then select System Calibration icon and press Enter.

Input Modes

DC-Differential

DC-Differential measures signals with a DC component. It uses a differential input mode to ignore the DC component and just measure the fluctuations (AC component) of the signal.

Differential mode is recommended when measuring signals with a common mode voltage (CMV). CMV is an in-phase signal that appears simultaneously on multiple input channels. If the sum of the signal and the CMV do not saturate the input and cause clipping, the measurement will be accurate. If the signal and CMV exceed the input range then the signal will be clipped and produce erroneous results. If the signal and CMV are very high and exceeds the maximum over-voltage rating of the instrument front end then the data will be erroneous
and the hardware can be damaged. This must be avoided to protect the hardware from permanent damage.

**DC-Single End**
DC-Single End allows measurement of signals with a DC component and uses single ended input mode. Single ended mode is recommended for most cases and when no CMV exists. This is the case when measuring the output of sensor amplifiers. A CMV will produce noise in single ended mode.

**AC-Differential**
AC-Differential applies a high-pass filter with a low cutoff frequency to the input, filtering the DC component of the signal. The result is a zero mean signal. This is most commonly used for dynamic signals with CMV.

**AC-Single End**
AC-Single End mode combines the AC high-pass filter with single ended mode. This is most commonly used for dynamic signals with no CMV such as measuring the output of an amplifier.

**IEPE (ICP)**
The CoCo supports IEPE constant current output type for its input channels. The built-in circuit is powered by a 4mA constant current source at roughly 21 Volts. IEPE refers to a type of transducer that is packaged with a built-in current source. IEPE is an acronym for Integral Electronic Piezoelectric. IEPE requires an AC filter so DC measurements are not possible when IEPE is enabled. CoCo has a cut-off frequency of 0.3Hz@-3dB for the IEPE input mode.

CoCo can automatically detect the IEPE sensor connection when the IEPE input mode is enabled. The sensor indication is shown in following three modes:

A green **IEPE** sign indicates that the IEPE is set in the channel table and the IEPE sensor is detected; a red **IEPE** sign with a strike-through indicates that the IEPE mode is set in the channel table but the sensor has not been detected. The empty space means that this channel is not set to IEPE.

**CoCo-80 Output Connections**
The CoCo-80 includes one output channel that can act as a function generator to provide a variety of waveforms synchronized with the input channel sampling rate. The output channel is a SMB mini-jack. A SMB-to-BNC adaptor is provided with the unit. For each waveform the parameters such as amplitude and frequency can be specified with the **Output Parameters** screen menu located in
the **F2 (Param.)** menu. The output waveforms include: Sine, Triangle, Square, White Noise, Pink Noise, DC, Chirp, Swept Sine, and (optionally) Arbitrary Waveform.

**CoCo-80 Peripherals and Accessories**

This section describes the peripherals and accessories available on the CoCo-80 including SD Card, audio devices, Ethernet, USB, audio and battery. The CoCo-80 includes interfaces to many peripheral devices. These can be connected to the hardware via the connectors shown below.

Figure 98. CoCo-80 Peripherals and Accessories.
## Item Descriptions:

<table>
<thead>
<tr>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>CoCo-80 Handheld Data Acquisition System</td>
</tr>
<tr>
<td>Suitcase with foam inside</td>
</tr>
<tr>
<td>Hang Strap</td>
</tr>
<tr>
<td>USB cable</td>
</tr>
<tr>
<td>Regular Ethernet cable</td>
</tr>
<tr>
<td>BNC cable</td>
</tr>
<tr>
<td>CD for EDM, the host software, User’s Manual in PDF</td>
</tr>
<tr>
<td>Cable for Output (Signal Source)</td>
</tr>
<tr>
<td>Main Battery (installed)</td>
</tr>
<tr>
<td>Cross-Over Ethernet Cable</td>
</tr>
<tr>
<td>AC/DC Power Adapter</td>
</tr>
<tr>
<td>Power Cable to AC Outlet</td>
</tr>
</tbody>
</table>

### Ethernet

CoCo is equipped with an RJ-45 100-BaseT Ethernet jack to connect to a local area network or directly to a PC. A cross-over Ethernet cable must be used to connect the CoCo-80 to a PC **directly**. If CoCo is connected to a network hub, router or a switch, then a regular Ethernet cable (not a crossover cable) should be used.
USB Ports

The CoCo-80 has two USB ports, one USB-client (mini-USB) and one USB-host (type A). They are fully compliant with USB 2.0 full speed specification and backward compatible with USB 1.1. The shapes of two ports are different, as shown below:

The USB-client port is used to establish communication between the CoCo-80 and a PC. When the USB-client port is used, CoCo-80 device acts as a slave unit.
The USB-host port is used to establish communication between the CoCo-80 and other USB-based peripherals, such as a USB-mouse, or a USB memory stick. In this case, the CoCo-80 acts as a USB master device.

**Mouse Support**

USB Mouse is supported with following operations: F1~F6 function buttons, two virtual keypads, scrolling and make selections in any combo box, ZOOM-in scaling, ZOOM-out scaling the graph.

To ZOOM-in on the graph, hold the left button of the mouse and drag to the area that you intent, then release the left butt

To ZOOM-out the graph to the previous scaling stage, double-click on the graph.

**SD Card Interface**

The MMC/SD-Card interface is designed to be used for multiple purposes, mainly the high density memory card. The official information about the MMC/SD-card can be found on the official site: [http://www.sdcard.org/](http://www.sdcard.org/)

The user can copy the recorded signal files from the internal flash memory to SD memory card or directly record the time stream data to SD memory card.

**Audio Devices**

CoCo-80 has the following built-in audio devices:

1. 3.5mm stereo jack connector for an earphone
2. Built-in speaker
3. Built-in microphone

The earphone and speaker are used to generate status sounds that provide audio feedback to the use such as:

1. AC adapter is connected
2. AC adapter power was disconnected
3. System boot-up successful
4. System boot-up failure

**Battery**

There are two batteries inside the CoCo-80 device, the clock battery and the main battery. The clock battery is only used maintain power to the internal clock. It is located inside the hardware and should be replaced when necessary by an authorized CI service center and should not be replaced by the user. The main battery is used to power the instrument. The main battery is a Lithium-Ion type cell with a capacity of up to 6600 milliamp-hours. The main battery is located
inside the enclosure and can be replaced by opening the lid on the back of the CoCo-80.

To recharge the main battery, simply connect the AC adaptor between the CoCo-80 and the AC power source. The power source must be in the range of 100 - 250 VAC. When the CoCo-80 is turned on, a battery capacity symbol is shown on the status bar that indicates the state of charge of the battery.

![Battery Charger](image)

Battery Charger

This is an optional accessory. This charger can charge the main battery without using CoCo. It is convenient to use this charger to charge an extra main battery while one is in use. This charger is designed and made by Crystal Instruments.

**DC/DC Converter for Car Cigarette**

This is a DC-DC adapter using automobile cigarette lighter, voltage isolated. Input: 9~30VDC. Output 15V/3A (±10%).

![DC/DC Converter](image)

With this converter, the user can use the power from the car cigarette adapter to support the CoCo.
CoCo-80 On-Line Updates

The CoCo-80 application software has the capability to check for software updates from the CI web server when you connect the CoCo-80 device to the Internet. You first connect the CoCo-80 to a local network using regular Ethernet. After you connect it, press Setup button and click the Update icon. The CoCo-80 will first check the connection status, and then a connection will be established.

After communication is established, the CoCo-80 will check with the server to verify if the software subscription is valid. If the CoCo-80 is in the valid software subscription period, it will then check the latest software components available on the server and download them to the CoCo-80 after the user’s approval.

Two types of software components can be updated:

- CoCo-80 application software
- CSA projects

The CoCo-80 user interface will always ask the user’s confirmation before the software is downloaded. When the new CoCo-80 application software is downloaded, you will be asked to confirm to overwrite the old version with the new version. Then the older version will be overwritten.
When new CSA projects are downloaded, if the new CSA files take the same file name as the old ones, the old CSA files will be renamed to the CSA files with sequence number added. This approach will prevent overwriting the old CSA files that may have been changed by the user.

If the connection to the Internet could not be established, please press the Setup button and click on the Connections icon. This will lead you to the Ethernet network setup. The most common problem is caused by inappropriate IP address setting. Most often, your LAN requires you set up the IP as “Dynamically obtain an IP via DHCP”. Please refer to section “Configuring the CoCo-80 Network Settings” in this manual for more details.

**CSA — Configurable Signal Analysis**

This section describes the Configurable Signal Analysis concept that is the basis for the CoCo-80 functionality and allows advanced users to customize the analysis features to suit individual needs. This section gives a brief description that is intended for the basic user. It does not describe writing projects for advanced users. For more on writing CoCo-80 analysis functions refer to the manual about CSA Editor that comes with EDM host software.

When the CoCo-80 powers up the Welcome screen is shown. From this screen the use must select one of the CSA projects loaded on the CoCo-80. When a CSA project is selected, the project defines the settings and analysis functions that are computed by the CoCo-80. These settings include the following:

1. Parameters used by the data conditioning functions such as Add, Subtract, Multiply, Divide, Square, Square Root, RMS, Scale, Offset, Decimate
2. Parameters used by the signal analyzer functions such as FFT, Auto Power Spec, Coherence, FRF
3. Time Stream Data Recording Settings
4. Block Data Save Settings
5. Trace Settings

The CSA is designed to control how the data is processed, not how the data is acquired. When the CSA is changed, the processing functions are changed according to the new CSA, but the data acquisition parameters do not change. For this reason, the following settings have global effect and are not part of CSA project:

1. Sampling Rate
2. Input Channels: sensitivity, coupling, channel labels
3. Output Channel: output waveform settings

All pre-programmed CSA projects have predefined parameters that are loaded when the project is selected. You can modify the parameters on the CoCo-80 from the Param Soft Button in the Display screen. Modified CSA projects can be saved with a different name using the Save As soft Button in the Analysis screen so that the original projects are not overwritten.

Most pre-programmed CSA projects carry a variable called Maximum Sampling Rate. This is the sampling rate that this CSA can safely execute without exceeding its computational resource limit. Maximum Sampling Rate is used to limit the selection of the sampling rates.

**Preprogrammed CSA projects**

The CoCo-80 is preprogrammed with a set of default CSA projects which provide a wide range of options that meet most users’ needs. Additional CSA projects may be downloaded from the Crystal Instruments web site. In addition, by using CSA Editor the advanced users may edit or develop their own customized CSA projects to meet their specialized needs. Typical default CSA projects are given below.
<table>
<thead>
<tr>
<th>CSA Group</th>
<th>CSAs used for 4-channel CoCo-80</th>
<th>CSAs used for 8-channel CoCo-80</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Conditioning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMS(4).csa</td>
<td>RMS(8).csa</td>
<td>Calculate the RMS of each input channel. Overlap ratio and average time are changeable.</td>
<td></td>
</tr>
<tr>
<td>Time(4).csa</td>
<td>Time(8).csa</td>
<td>Apply no data conditioning for any channel. Only show the native input channels.</td>
<td></td>
</tr>
<tr>
<td>PkPk(4).csa</td>
<td>PkPk(8).csa</td>
<td>Calculate the peak-to-peak value for each channel.</td>
<td></td>
</tr>
<tr>
<td>Subtract(4).csa</td>
<td>Subtract(8).csa</td>
<td>Channel 1 is subtracted from each other channel.</td>
<td></td>
</tr>
<tr>
<td>Multiply(4).csa</td>
<td>Multiply(8).csa</td>
<td>Multiply each channel by channel.</td>
<td></td>
</tr>
<tr>
<td>Add(4).csa</td>
<td>Add(8).csa</td>
<td>Add channel 1 to other channels.</td>
<td></td>
</tr>
<tr>
<td>Integration(4).csa</td>
<td>Integration(8).csa</td>
<td>Digitally integrate each channel. Suitable for signals with higher frequency content.</td>
<td></td>
</tr>
<tr>
<td>IntegrationLow(4).csa</td>
<td>IntegrationLow(8).csa</td>
<td>Digitally integrate each channel. Suitable for signals with low frequency content.</td>
<td></td>
</tr>
<tr>
<td>OffsetScale(4).csa</td>
<td>OffsetScale(8).csa</td>
<td>Apply an offset and a multiplier to each channel. The offset and multiplier can be modified in Analysis Parameters.</td>
<td></td>
</tr>
<tr>
<td>Transient Capture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transient(4).csa</td>
<td>Transient(8).csa</td>
<td>Time streams from each channel are captured into block signals by enabling Acquisition Mode.</td>
<td></td>
</tr>
<tr>
<td>Capture1Ch(4).csa</td>
<td>Capture1Ch(8).csa</td>
<td>Block-capture the channel 1 with up to 64k buffer size</td>
<td></td>
</tr>
<tr>
<td>Linear and Power Spectra</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AutoPowerSpec(4).csa</td>
<td>AutoPowerSpec(8).csa</td>
<td>Transform the time streams into block signals then apply data window and FFT to calculate auto power spectra. FRF/Coh will not be calculated.</td>
<td></td>
</tr>
<tr>
<td>APS1Ch(4).csa</td>
<td>APS1Ch(8).csa</td>
<td>Only calculate the auto spectrum for 1 channel with up to 64K buffer size.</td>
<td></td>
</tr>
<tr>
<td>FFT(4).csa</td>
<td>FFT(8).csa</td>
<td>Transform the time streams into block signals then apply data window and FFT.</td>
<td></td>
</tr>
<tr>
<td>Frequency Response</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRF(4).csa</td>
<td>FRF(8).csa</td>
<td>Calculate the frequency responses when channel 1 set as reference and the others as responses.</td>
<td></td>
</tr>
<tr>
<td>CSA Group</td>
<td>CSAs used for 4-channel CoCo-80</td>
<td>CSAs used for 8-channel CoCo-80</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------------------</td>
<td>---------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>CrossPowerSpec(4).csa</td>
<td>CrossPowerSpec(8).csa</td>
<td>Calculate the cross power spectra when channel 1 set as reference and the others as responses.</td>
</tr>
<tr>
<td></td>
<td>FRF_COH(4).csa</td>
<td>FRF_COH(8).csa</td>
<td>Calculate the FRF and coherence when channel 1 set as reference and the others as responses.</td>
</tr>
<tr>
<td></td>
<td>FRF_COH_CPS_APS(4).csa</td>
<td>FRF_COH_CPS_APS(5).csa</td>
<td>Calculate the FRF, cross-power, auto-spectra and coherence functions when channel 1 set as reference and the others as responses.</td>
</tr>
<tr>
<td>Real-time Digital Filter</td>
<td>DecimFltr(4).csa</td>
<td>DecimFltr(6).csa</td>
<td>Apply n stage of 2:1 decimation to each input channel to obtain the signals with lower sample rate.</td>
</tr>
<tr>
<td>Acoustic Analysis</td>
<td>OCT(4).csa</td>
<td>OCT(8).csa</td>
<td>Apply 1/1, 1/3, 1/6 or 1/12 octave filters to time streams and generate octave spectra and filter RMS time traces. It conforms to ANSI std. S1.11:2004 and IEC 61260-1995.</td>
</tr>
<tr>
<td></td>
<td>OCT RPM(4).csa</td>
<td>OCT RPM(8).csa</td>
<td>Apply 1/1, 1/3, 1/6 or 1/12 octave filters to time streams and generate octave spectra and filter RPM traces. It conforms to ANSI std. S1.11:2004 and IEC 61260-1995.</td>
</tr>
<tr>
<td></td>
<td>SLM(4).csa</td>
<td>SLM(8).csa</td>
<td>Sound Level Meter (SLM) template provides various overall sound level readings.</td>
</tr>
</tbody>
</table>
When a CSA project is running you can choose to display, record or save data streams or signals.

**Change CSA projects from the CoCo-80**

A CSA project specifies the analysis settings and functions including: analysis parameters and functions, time stream recording, block data save and trace settings. After a CSA is selected it can be modified from the CoCo-80 to change these parameters using the *Traces* and *Param* soft buttons in the Display screen. The modified CSA can then be saved using the Save As soft button in the Analysis screen. This allows modified CSAs to be saved and used again later.

**Editing CSA from the EDM Software**

CSA files can also be edited or new CSA files can be created from scratch from the EDM software on a PC. This feature allows the advanced end user to create custom analysis functions to suit their special needs. This advanced topic is not covered in this manual. Refer to the CI Support web page for documentation about editing CSA from the EDM software.
To initiate the CSA Editor, click on the CSA Editor icon on the upper-left corner of EDM.

**Signal Processing in the CoCo**

In a global picture, the signals will go through the following stages in the analyzer:

First the analog signals will be processed by the analog signal conditioning circuitry. It usually includes input mode selection logic, the high-pass filter for AC coupling and constant current source for IEPE. Then the analog signals will be digitized simultaneously by multiple A/D converters. The digital signals coming out of A/D converters, after a calibration process, will be fed into the DSP processor.

The CoCo may first turn on a pre data conditioning algorithm. This pre-data conditioning algorithm may apply the high-pass filters so to reduce the DC drift, or convert the acceleration signals into velocity or displacement. It will also apply the appropriate engineering unit setting to the input signals.

Then the data streams will be fed into a user controlled Data Conditioning module, and then spectral analysis. This part will be explained in detail in the next section.

**The Data Processing Flow of CoCo**

CoCo-80 combines two instruments, a data recorder, and a signal analyzer into one system. It is important to understand the differences between these two functions. The following sections provide details of each.

The data conditioning and recording phase includes processing the data from native acquisition channels and data conditioning. Data conditioning operations include arithmetic operations such as adding or subtracting, filtering, integration, differentiation, calibration and other operations that can be applied to the continuous time streams. All the signals in the data conditioning and recording stage are continuous time streams with a fixed sampling rate without any gaps. Time streams can be displayed or recorded.
The signal analyzer phase includes the Acquisition Mode and CSA based block-by-block processing. The acquisition mode controls how the continuous time streams are captured into fixed-sized blocks. The processing phase applies algorithms such as spectral analysis to the blocks.

Figure 100 shows how the input data is processed in the data conditioning and signal analyzer phases.

The system has two dedicated buttons that control the data acquisition. **Rec./Stop** button only applies to the continuous time streams in the data conditioning phase while the **Save** button only applies to the captured time buffer and spectral signals in the signal analyzer phase. Recording and Save cannot be performed at the same time. In the other words, when the time stream is being recorded, the spectral analysis cannot be saved. To save a spectral analysis signal the time recording must first be stopped.

**Re-Start** soft button re-initializes the data conditioning, acquisition mode control and spectral analysis. It resets the timer of time streams, re-arm the trigger and reset the average number of spectral analysis.
**Block Size** governs the size of transient capture or FFT blocks in the signal analyzer phase. Block Size has no influence on the length of the time streams in the data conditioning phase.

Both time streams and block-by-block signals can be displayed with continuous update (Run mode) or frozen on the screen (Hold mode). In the signal display window the F6 soft button is assigned to the **Run/Hold** function. Hold means the display are frozen on the screen. Hold does not stop the data conditioning and recording process. If data is being recorded and the Hold button is pressed, the data will continue to be recorded until the Rec/Stop button is pressed again.

The actual Data Conditioning and Signal Analysis function processing are defined by a special technology, CSA, as described in the following section.

**Acquisition Modes**

This section describes the Acquisition Mode, which defines how the device captures block by block data from continuous time streams, usually in response to trigger events.

The instrument separates the data processing into three stages: data conditioning, acquisition mode, and signal analysis. Acquisition Mode controls how the continuous time stream data is captured for block-by-block processing. Acquisition Mode control is applied after data conditioning and before the signal analysis stage. If a CSA does not include a block capture function then Acquisition Mode will not be used.

![Figure 101. Data processing is separated into three stages.](image)

Note: in the description below, sometimes when we say “capture a block of data”, it really means that multiple blocks of data are captured from their own time streams. These blocks are all accurately time-synchronized.

**Free Run** displays block data acquired from the time stream as fast as possible or at the overlap rate set by the user. Free Run is commonly used to analyze random or irregular signals.
**Continuous after Trigger** waits until a trigger event is detected. After the first trigger event, averaging begins from zero and the system runs in Free Run mode.

**Single Shot with Trigger** waits until a trigger event is detected, then acquires one block of data and stops. This mode is the best if you want to observe the time signal block by block at a certain trigger event.

**Single Shot without Trigger** acquires one block every time the user presses the Run button. This mode is best for observing a time signal block by block at arbitrary times.

**Auto-Arm Trigger** acquires one block of data every time a trigger event is detected. This block is added to the current average based on the average mode settings under Analysis Parameters. If another trigger event is detected, a new block of data will be acquired. This process will continue indefinitely with no user interaction.

This mode can be used for time synchronous averaging with the average mode set to *Time Linear* or *Time Exponential*.

**Manual-Arm Trigger** works like Auto-Arm trigger but prompts the user to accept or reject each captured block. Only accepted blocks are added to the average. This mode is the best for applications such as impact hammer testing where you may not have confidence in the signal quality of some of the data blocks.

**Trigger Source**

Trigger Source defines what signal is used to determine a trigger event. Any time stream that is set as trigger source candidate in the CSA can be selected as trigger source on the CoCo-80. If a signal is not identified as a trigger source candidate in the CSA file then the signal will not appear on the list. This feature is designed to simplify the user interface and optimize the CoCo-80 computational resources.

The candidates of Acquisition Mode selection and Trigger Source selection will be defined by the CSA editor. The CSA editor will assign some the data streams after the data conditioning as candidates of trigger sources. For example, in a CSA there are 8 channels, if you only select ch1 and ch2 time streams as candidates of trigger source and then this CSA will only show ch1 and ch2 on the trigger source selection menu.

You may also define time streams other than native channels as trigger source candidate. For example, if in the CSA an RMS measurement is derived from ch1, this RMS time stream can be used as a trigger source.
**Trigger Condition**

Trigger Condition defines when a trigger is detected based on the signal level and the slope. The four choices are:

- Trigger Source > High Level (rising edge)
- Trigger Source < Low Level (falling edge)
- Low Level < Trigger Source < High Level (level trigger)
- (Trigger Source > High Level) OR (Trigger Source < Low Level) (edge trigger)

There are two types of trigger detection, one is called edge detection; the second level detection. In the trigger conditions above, 1, 2 and 4 are edge detection and 3 the level detection. Edge detection compares at least two sample points against the threshold level. Level detection only detects one sample point.

When **Free Run** is selected, trigger source and level are not needed.

The table below visually explains when the trigger event will happen in these four conditions. The red mark shows the instant in time that the trigger event is detected:
<table>
<thead>
<tr>
<th>Trigger Condition</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigger Source &gt; High Level (rising edge)</td>
<td><img src="https://example.com/diagram1.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Trigger Source &lt; Low Level (falling edge)</td>
<td><img src="https://example.com/diagram2.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Low Level &lt; Trigger Source &lt; High Level (level trigger)</td>
<td><img src="https://example.com/diagram3.png" alt="Diagram" /></td>
</tr>
<tr>
<td>(Trigger Source &gt; High Level) OR (Trigger Source &lt; Low Level) (edge trigger)</td>
<td><img src="https://example.com/diagram4.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

**Trigger Delay**

Trigger delay allows a captured signal to include some data before or after the trigger event. This is done by defining some number of points, or the percentage of the total Block Size, that the capture occurs after the trigger event. For example, if the Block Size is set to 1024 and the trigger delay is 10%, the data capture will happen 102 points after the trigger event.

A negative trigger delay is more common for transient data capture. Negative trigger delay means that the data capture will include data points before the trigger event. For example, a -10% trigger delay means that the data capture will include 102 data points before the trigger event with Block Size 1024. Some instruments call a negative trigger delay a **Pre-Trigger**. The following picture shows the concept of a negative trigger delay:
Overlap

When overlap is enabled, consecutive data blocks have overlapped samples. This reduces the averaging time. Overlap is only used when the Acquisition Mode is set to **Free Run** or **Continuous after Trigger**. Otherwise it is not used. Continuous capture without further trigger can also use overlapping.

**No Overlap** – Overlap is not applied.

**Automatic** – System determines the best overlap rate

Acquisition Mode Setup

This section explains how to set up the acquisition mode and the trigger related parameters. First select the Acquisition Mode under the Param. Setting then the acquisition mode screen will be shown.

The soft buttons are assigned with different functions:

Press F1 to select one of the acquisition modes:

When the Acquisition Mode is not **Free Run**, the Trigger Source, Trigger Condition must be defined.
Press F2, Trigger Source, to select one of the time streams as the trigger source. These time streams are set as Trigger Source Candidates by the CSA Editor when this CSA project is created on the host PC.

Press F3, Trigger Cond., to select one of the trigger conditions. You can also key in the trigger level(s) using Editing Level entry.

The arrow buttons can also be used to set the trigger level and delay settings.

Use the arrow buttons to change the trigger level and delay while the data stream from the trigger source is displayed.

Press F4 to activate one of four functions for the navigation arrow buttons:
- Auto Scale Window
- Fixed Scale Window: Arrow buttons used for expanding or reducing the scales
- Move Window: Arrow buttons used to shift the positions of the window
- Set Trigger Level: Arrow buttons are used to set the high threshold level, low threshold level, and trigger delay

The method 3 is a more convenient way to set the trigger threshold level instead of using the editing tool under F3. The editing tool allows you to set the trigger level to a precise value.

Press F5 to set the overlap rate. This factor will only have effect when the acquisition mode is set as Free Run or Continuous after Trigger.

After all trigger parameters are set, press F6 (OK) button then the system will exit to the main measurement display window.

Using a Trigger During Measurement

This section explains the trigger operation while making measurements. Manual-Arm Triggering is the most common mode and will be described first and in the most detail. The other types will be explained briefly afterwards.

Manual Arm Trigger

When the Acquisition mode is setup then a small popup window is displayed as shown in Figure 103 indicating that the system is waiting for a trigger event. No signals are displayed until a trigger event is detected.

![Figure 103. Waiting for trigger message.](image-url)
You can change from the waiting for trigger mode to Hold mode by pressing the F6 (Hold) button. The window will close and the system will change to Hold mode.

Press Restart (F3) or Run (F6) to reopen the window and return to the waiting for trigger mode.

When a trigger event occurs due to the Trigger Source signal meeting the trigger condition, the popup window will show a block of capture of data from the trigger source signal.

The display will depend on the type of signals in the pane.

If a time stream is displayed then the display will update continuously. You will not notice the difference before or after trigger event for the time stream.

If a block signal is displayed, the block signal(s) in the background window will be updated with the new content.

If a block signal in the frequency domain is displayed, it will not be updated because you have not “accept” the time signal yet.

Now you may do one of two things: Accept or Reject.

If you press the Accept button, the acquired block signals will be passed to the signal analysis stage, usually windowing, FFT and spectral analysis. Then you can continue to the Next frame of capture.

After you press the Next key, the system will go back to waiting in trigger mode.
If you press **Reject** then the captured time signals will be discarded and will not be sent to signal analysis stage. After the **Reject** action, the system goes back to waiting in trigger mode.

The number showed on the top status bar, #N, indicates the number of the frames of the time captures that have been accepted and averaged into the spectra.

After you press the **Hide** key, the small form window will disappear. Press **Enter** to show this window again.

During trigger operation you can switch the main display window to any trace. This can be helpful to view the time stream selected as the trigger source to tune the level and slope settings.

**Time-Synchronous Averaging**

In some measurement situations, it is desirable to average together multiple periods of a periodic time signal. This will average out random noise, and leave only the periodic part of the signal. However, this relies on the ability of the averaging function to align each successive period. One method to do this involves synchronous triggering, where one signal marks each period of another signal. The averaging is then triggered by this second signal. The most common example of this is when the averaging is done on a signal from a sensor connected to a rotating machine, and a tachometer pulse signal is used for triggering.

Time-synchronous averaging can be done on the CoCo using the Auto-arm trigger mode and the Time Exponential or Time Linear average mode. A time-synchronous averaged signal is shown in Figure 105.

![Figure 105. Regular average (left) vs. time-synchronous average (right)](image-url)
Built-In Digital Integration

Ideally a measurement is made using a sensor that directly measures the desired quantity. For example an accelerometer should be used to measure acceleration, a laser velocimeter or velocity pickup should be used to measure velocity and an LVDT should be used to measure position. However since position, velocity and acceleration are related by the time derivatives it should be possible to measure an acceleration signal and then compute the velocity and position by mathematical integration. Alternatively you can measure position and compute velocity and acceleration by differentiating. The integration can be performed at the analog hardware level or at the digital level.

The CoCo provides a means to digitally integrate or double integrate the incoming signals. The integration module fits into the very first stage after data is digitized, as shown below:

There are several issues to address in such implementation:

The integration and double integration algorithm has to be accurate enough and it must find a way to reduce the effects of a DC offset. A tiny initial value, offset in the measurement or temperature drift before the integration, may result in a huge value after single or double integration. This DC effect can be removed using a high-pass filter.

The initial digital signal must have a high signal to noise ration and high dynamic range. The integration process in essence will reduce the high frequency energy and elevate the low frequency components. If the original signals do not have good signal noise ratio and dynamic range, the signals after integration and double integration will have too much noise to use. The noise will corrupt the integrated signal.

The instrument must be able to set two different engineering units: one engineering unit for the input transducer and a second engineering unit after the integration. For example, first the instrument must provide a means to set the sensitivity of the sensor, say 100 mV/g. After the double integration the instrument must have the means to set the engineering unit to a unit that is compatible with the integration such as mm.
The CoCo instrument handles these three issues effectively so you can get reliable velocity or displacement signals from the acceleration measurement, or displacement signals from the velocity measurement. The CoCo hardware has a unique design to provide 130dB dynamic range in its front-end measurement. The signals with high dynamic range will create better results after digital integration.

Since such build-in integration is conducted in the time domain before any other data conditioning or spectral analysis, the time streams generated after the digital integration can be treated in the same way as other time streams. They can be analyzed or recorded.

CoCo also provides differentiation and double differentiation to calculate the acceleration or velocity from velocity or displacement transducers. Differentiation is not as common as integration.

It must be noticed that the displacement after double integration to the acceleration is not the same as that measured by a proximity probe. A proximity probe measures the relative displacement between an moving object to the fixed coordinates seated by the probe. The accelerometer and its integration value can only measure the movement of the moving object against the gravity field.

Sensor Consideration

Accelerometer signals that are non-dynamic, non-vibratory, static or quasi-static in nature (low acceleration of an automobile or flight path of a rocket) are typically integrated in the digital domain, downstream of the signal conditioner. Piezoelectric and IEPE accelerometers are commonly used to measure dynamic acceleration and, therefore, dynamic velocity and displacement. They should not be used to measure static or quasi-static accelerations, velocities, or displacements because the IEPE includes analog high pass filtering in the sensor conditioning that cuts out any low frequency signal. At frequencies approaching 0 Hz, piezoelectric and IEPE accelerometers cannot, with the accuracy required for integration, represent the low frequency accelerations of a test article.

When this slight inaccuracy is integrated in order to determine velocity and displacement, it becomes quite large. As a result, the velocity and displacement data are grossly inaccurate. A piezoresistive or variable-capacitance accelerometer is a better choice for low frequency signals and for integration. These types of sensors measure accelerations accurately at frequencies approaching 0 Hz. Therefore the integration calculation of velocity and position can be used to produce accurate results.
Calculation Errors in Digital Integration

Two types of calculation errors can be caused by digital integration: low sampling rate and DC offset.

The sampling rate of a signal must be high enough so that the digital signal can accurately depict the analog signal shape. Some people may think that according to the Nyquist sampling theorem as long as the sampling speed is more than twice of the frequency content of the signals before the integration, the integration results should be acceptable. This is not true. Satisfying the Nyquist frequency only ensures an accurate estimate of the frequency of a measurement. Integration error can still occur if a signal is not sampled at more than twice the signal frequency. Figure 106 shows a 1 kHz sine wave sampled at 8 kHz and 5.12 kHz.

![Figure 106. A 1 kHz sine wave sampled at 8 kHz (top) and also sampled at 5.12 kHz (bottom).](image)

It is clear that the higher the sampling frequency, the closer this digitized signal is to the true analog waveform. When the sampling rate is low, the digital integration will have significant calculation error. For example the 5.12 kHz sampled signal is not symmetric about 0 volts so the integration will drift and a double integration may grow with accumulated error very fast.

In general, you should use a sampling rate 10 times higher than the frequency content that is of interest in the signal when you apply numerical integration.

DC offset is the second type of digital integration error and can be more severe. It is caused by any measurement error before integration and may result in huge amplitude errors after the integration. Figure 107 shows how a small measurement error in acceleration will create a constant DC offset in the
acceleration integrated to compute velocity and result in a drift and eventually an infinite large magnitude of displacement after double integration.

![Graph](image)

Figure 107. A small error in acceleration results in a DC offset in velocity and a huge drift in displacement.

Of course, the computed velocity and displacement signals are unrealistic. They are artifacts of the integration errors. In order to remove such a problem caused by inaccurate measurement and digital integration, a high pass filter can be applied before or after the integration. It should be noted that the high-pass filter will distort the waveform shape to some extent because it alters the low frequency content of the signal. However this effect must be tolerated if numerical integration is used.

**Digital High-Pass Filter**

The most effective way to remove the DC drift effect as described above is to apply a high pass digital filter to the continuous time streams. In CoCo, a unique algorithm is realized so that even the data is sampled at high rate, the high pass filter can still achieve very low cutoff frequency.

The filter cutoff frequency is specified at -3dB attenuation.

To remove unwanted signals at or near DC, please set up the cutoff frequency of the digital high-pass filter as high as possible as long as it won’t chop off useful frequency content of your interest.

To give an example, if you are not interested in any frequency less than 20Hz, then you can set the cutoff frequency to approximately 10Hz. With this setting, the amplitude attenuation at 20Hz will be less than 1dB.

The following picture shows that ch1 sets the high-pass filter at 15Hz and ch2 at 50Hz. Others are at 1Hz.
Using Integration

Integration can be enabled in the Input Channel table. In CoCo, to set up the built-in integration or double integration, you must set two engineering units. The first one is for sensor sensitivity; the second for the engineering unit after the integration or differentiation. For example, you can choose either $g$ or $m/s^2$ as the engineering unit used for the accelerometers. After the double integration, you can choose one from the list of meter, cm, mm or other displacement units for displacement presentation.

Example

First select the Acceleration or Velocity in the input channel table:

![Image of Sensor sensitivity without integration.](image)

Figure 108. Sensor sensitivity without integration.

Then select the engineering unit of the sensor to be used and set its sensitivity.

Under the item of Selection integration or differentiation, select appropriate item. The example shows Double Integration to Displacement is selected.
Select the appropriate engineering units for displacement. The example shows displacement units of millimeters.

With this setup, the accelerometer is set to measure $g$ while the displacement is using millimeter as the output unit. The sensor sensitivity $50 \text{ mV/g}$ transforms the input voltage into $g$ appropriately.

To enable or set the high-pass filter, simply go to the channel table and highlight the column of Hi-Pass Fltr, and press Enter button. Each channel can have its independent cutoff filter values.
CoCo-80 Operation for Spectral Analysis

This section describes the operations of CoCo that are specifically related to the FFT spectral analysis. For general operations of CoCo, refer to the previous chapters of this manual.

Select a CSA Project

To run a spectral analysis CSA, press the Analysis button and select either the Linear and Power Spectra or the Frequency Response Application group, then select one of the CSA spectral analysis projects.

Figure 110. CoCo Select Analysis Function selection display.

Set Analysis Parameters for Spectral Analysis

To set the parameters for spectral analysis, press the Param. Button in the signal display window, select Analysis Parameters, then set the parameters.
**Block Size:** the block size of the time block signals.

**Average Mode:** Exponential, Linear or Peak Hold applied to frequency domain, power spectra averaging. Time Linear and Time Exponential applies to time domain averaging.

**Average Number:** the Average number of linear averages. When exponential average is selected as the average mode, $1/(\text{Average Number})$ is used as the exponential factor.

**Window Type:** type of data window.

The selection candidates of these fields are defined in the CSA Editor. That is, the maximum sampling rate, maximum number of input channels, etc are defined when you create the CSA. For example if you select a Maximum Sampling Rate of 1 kHz in the CSA Editor then higher sampling rates will not be available on the CoCo device. If a higher sampling rate is required then you must modify the CSA and download it to the CoCo. Although this behavior may seem limiting, it should be noted that it allows the user to choose exactly the analysis functions and optimize the performance of the CoCo device to suit your specific needs and is one of the unique features of the CoCo system.

**Weighting Type:** CoCo offers Z, A, B, and C weighting.

**Set the Spectrum Type**

To set the Spectrum type, press Display button to set the Display Preferences.

---

Figure 111. CoCo Analysis Parameters selection display.
Set the Output Channel Parameters

To enable the output channel as a function generator select Output Channel from the Param. Button. Next select the waveform. To set the amplitude and frequency and other parameters move the cursor to the parameter and press the Enter Button to edit the parameter.

To select an arbitrary waveform first select Arb Wave as the output type, then press the Arbitrary Wave Button to choose from all the wave files that are loaded on the CoCo.
Select the waveform from the list on the left and use the Arrow Buttons to move the cursor to the quiet zone, duration and peak output level settings on the right. Press the Enter Button to edit any of these parameters.

To start the output channel press the Enable button.

**Create Display Window and Set up the Trace**

To create a display window select Trace and Window Setting under the Param. Button. Use the soft buttons to add or delete a window, clear the signals from the current window, select all signals or change the view mode to show a numerical value. Change the signals in each window by selecting a specific window tab with the left or right buttons then editing the window settings.
Most often, amplitude or power spectra are shown in the logarithmic unit decibels (dB). Using this unit of measure, it is easy to view wide dynamic ranges; that is, it is easy to see small signal components in the presence of large ones. The decibel is a unit of ratio and is computed as:

$$\text{dB} = 10\log_{10}\left(\frac{\text{Power}}{P_{\text{ref}}}\right)$$

where Power is the measured power and $P_{\text{ref}}$ is the reference power. For amplitude ratios, the formula is:

$$\text{dB} = 20\log_{10}\left(\frac{\text{Ampl}}{A_{\text{ref}}}\right)$$

where Ampl is the measured amplitude and $A_{\text{ref}}$ is the reference amplitude.

When using amplitude or power as the amplitude-squared of the same signal, the resulting decibel level is exactly the same. Multiplying the decibel ratio by two is equivalent to squaring the ratio. Therefore, you obtain the same decibel level and display regardless of whether you use the amplitude or power spectrum.

As shown in the preceding equations for power and amplitude, you must supply a reference for a measure in decibels. This reference then corresponds to the 0 dB level. Different conventions are used for different types of signals. A common convention is to use the reference 1 Vrms for amplitude or 1 Vrms squared for power, yielding a unit in dBV or dBVrms. In this case, 1 Vrms corresponds to 0 dB.

Another common form of dB is dBm, which corresponds to a reference of 1 mW into a load of 50 Ω for radio frequencies where 0 dB is 0.22 Vrms, or 600 Ω for audio frequencies where 0 dB is 0.78 Vrms.

The picture below shows a sine wave with 1 V amplitude displayed in dB. Because the reference is 1 Vpk, it shows the peak value of this sine wave as 0 dB.

![Sine wave in dB](image)

**Figure 116.** Show a 1Vpk sine signal in frequency domain with dB scaling.
Another display format is called Log, or LogMag. The Log display shows the signal scaled logarithmically with the grid values and cursor readings in actual engineering value. The picture below shows the same signal in LogMag.

![LogMag Display](image)

**Figure 117.** A 1Vpk sine signal in frequency domain with LogMag scaling.

When dB reference is not specified, the dB reference is 1.0 engineering units. In acoustics application, the dB reference for the sound pressure value is set to 20 μPa. The same input signal will result in different dB readings when dB reference is changed.

**Set Acquisition Mode**

The appropriate acquisition mode should be set to transform the time streams into blocks. The details of acquisition mode for transient capture are described in the next chapter, *Transient Capture and Hammer Test*.

For frequency analysis that use stable and continuous excitation signals, use either Free-Run or Continuous after Trigger mode in the Acquisition Mode selection.

For details about setting the acquisition mode, refer to the Basic Operation of CoCo-80.

**Set Overlap Ratio**

The overlap ratio is set in the Acquisition Mode. The overlap ratio setting will only be effective when the Mode is selected as Free-run or Continuous after Trigger. For triggered transient capture, there will be gaps between frames and an Overlap Ratio cannot be applied.
Select the View Mode

The View Mode defines how the data will be displayed on the screen. To change the view mode select View Mode for Current Trace under the Param. button.

Signal Plot displays a graph of the plot vs. time or frequencies.

Current Value shows a numerical display of the current value of the signal.

Peak Value, Pk-Pk Value, Maximum Value, Minimum Value and Averaged Value show a numerical display of the results of the current data block.
CoCo Operation for Transient Capture

Select a CSA Project

This section discusses the CoCo settings that are specifically related to transient capture applications. For a complete explanation of these settings refer to the Basic CoCo Operation section. To run a Transient Capture CSA press the Analysis button and select a CSA Application Group that includes transient capture option. These include: Transient Capture, Linear and Power Spectrum, and Frequency Response. Then, choose an Analysis Function from the CSA files on the CoCo to run.

Analysis Parameters: Window Type

First you must specify the Analysis Parameters under the Param. Button. Select the averaging mode, averaging number and data window type. Transient Capture commonly uses the Force, Exponential or combination Force-Exponential data window function. Press the Apply button to accept the settings.

![Figure 120. Select the data window type for transient capture.](image)

Acquisition Mode

Next select Acquisition Mode under the Param. Acquisition Mode controls how the data is acquired and under what conditions. It includes setting the trigger mode, trigger source, level, conditions and overlap.

Select Trigger Mode using the Mode Button. Transient capture projects such as impact hammer tests typically use Manual-Arm Trigger or Auto-Arm Trigger. Auto-Arm automatically accepts the data frame into the average and prepares the trigger for the next signal. Manual-Arm provides a graphical display of the data and allows you to accept or reject the frame into the average.
Trigger Source defines which signal to use as the trigger source. Only signals specified in the CSA script are available as trigger sources. If a signal is not available then it can be added as a trigger source by editing the CSA file and downloading it to the CoCo hardware.

The Trigger Condition and Level Setup define the conditions that will trigger the acquisition. You can also edit the high and low level and the trigger delay. Alternatively you can change the level settings with the up and down arrow buttons.

Overlap defines the amount of overlap between frames for averaging to reduce the time required to acquire a large number of averages.
After the Parameter Settings are specified the CoCo begins to wait for a trigger event. A window displays the time elapsed before a trigger event is detected.

When a trigger event is detected and Manual-Arm Trigger is selected, then a small window will show the data frame and give you the option to accept or reject the data. Accept will include the frame into the average and then ask you to proceed to the next trigger by pressing the Next button. Reject will discard the frame, not include it in the average and return to the waiting for trigger mode. If Auto-Arm Trigger mode is selected then the system will automatically return to the wait mode after each trigger event with no user intervention.
The frame average number is displayed in the status bar to help you monitor how many averages have been recorded. When the averaging mode is set to linear and you reached the averaging number you are prompted to restart a new test by pressing the Run Button.

When the averaging mode is set to exponential then new frames will be acquired and included in the average until you press the Hold Button. The system does not stop when the average number reaches the averaging number. The averaging number only defines the behavior of the averaging function. Exponential averaging is intended for continuous averaging to help observe how a signal changes over time or converges to a mean.

![Figure 125. Accept/Reject display for transient capture.](image)

**Figure 125.** Accept/Reject display for transient capture.

![Figure 126. When averaging is complete you can restart a new test with the Run Button.](image)

**Figure 126.** When averaging is complete you can restart a new test with the Run Button.
Save Averaged Data

Data can be saved at any time by pressing the Save Hardware Button. This opens a menu with several options. Press the Save Button again to save the signals in the save list. This can be done in the middle of an average or at the end.

Select Define signals in the list to add or remove signals from the save list or setup automatic data save feature.

Figure 127. Save data by pressing the Save hardware button.
### Saving and Recording Data

Ranging from different applications, several ways are devised to save the signals that are being measured. The media of storage can be either internal flash memory or SD memory card.

**Save Long Time Waveform Signal**: the time streams can be saved either automatically by a preset schedule or manually.

**Save Block Signals**: The transient capture time signals, frequency signals or other block signals can be saved automatically or manually.

**Save Points**: The current value of the time streams, or RMS of a spectrum, or multiple statistics of signals, can be saved automatically or manually in to one file over long period of time. This is particularly useful in the monitoring applications.

The data can be saved either manually or automatically.

### Save Long Time Waveform Signals

The Rec./Stop Button is used to control the streaming of time stream data to memory. After a CSA project is selected, pressing the Rec./Stop button will start the display and also start recording the time stream to memory. The red flashing Rec icon at the top of the screen indicates that the data is recording.

To stop the recording press the Rec./Stop button again. The red flashing Rec icon will not be displayed indicating that the recording has stopped.

Before a time stream can be recorded it must be defined in the Parameter Settings/Time Steam Recording Setup. If no time streams are defined in this setting when the Rec./Stop button in pressed then a message will indicate that no signal are selected.

The Rec./Stop button can also be pressed after the Run button is pressed. The Run button starts the display of live signals but does not start recording. After a recording is stopped the display will continue to display live signals until the Hold button is pressed.

A special data compression algorithm is developed in order to save the storage space. It only applies to time stream recording.

For uncompressed data, use following formula to calculate the total time duration that you can record:

\[
\text{Total Installed Flash Memory in Bytes} = (\text{No. of Channels}) \times (\text{Recording Time in Seconds}) \times (\text{Sampling Rate}) \times 8 \text{ Bytes} \times 1.2
\]
Or

\[
\text{Recording Time in Seconds} = \frac{\text{Total Installed Memory in Bytes}}{(\text{No. of Channels}) \times (\text{Sampling Rate}) \times 8 \text{ Bytes} \times 1.2}
\]

For example if you enabled 6 channels, the sampling rate is 100 Hz with 4GB memory installed:

\[
\text{Recording Time in Seconds} = \frac{4\text{GB}}{(6 \times 100 \times 8 	imes 1.2)} = 4 \times 1024 \times 1024 \times 1024 / (6 \times 100 \times 8 \times 1.2) = 745654 \text{ sec} (= 207 \text{ hours})
\]

When data compression is used, the storage space will be doubled. The spectrum dynamic range of compressed data will be reduced to about 100dB. If the storage space and downloading time is not an issue for your application, then data compression should not be used.

The figure below illustrates the difference between the concepts of **Display - Run/Hold**, **Time Stream - Record/Stop** and **Signal - Save**. The Display mode is independent of the Record or Save functions. When you change the Display mode between Run and Hold it has no effect on the Save or Record functions. That means that time streams can continue to be recorded when the display is in Hold mode.

Figure 128. Illustration of the difference between Display Run/Hold, Time Stream Record/Stop and Signal Save.
Save Block Signals

Data can be saved by defining which signals to save and under what conditions. Select Spectral Save Setup under the Param. Button.

Choose which signals should be saved by using the Up and Down Arrows and the Enter Button to add a check next to the desired signals. These signals will be saved during a measurement when you manually press the Save Button.

In addition, these signals can be automatically saved by placing a check next to Also enable a timer and specifying the number of seconds between automatic saves. The signals can be saved with no delay between blocks by selecting Save.
Signals Continuously. This option can be used to view all data blocks on a waterfall plot.

Save Points

Save Points function saves a data point per signal at one time. This function is particularly useful in the very long period monitoring applications. For example, people can save and monitor the vibration or acoustic level over a few months by looking at the data points saved every hour.

All data points in one test will be saved into one data file. The user can easily open, view and analyze the data files using EDM PC software.

To set up the Save Points, first go to Param.->Signal Save Predefined List screen, then press F4 the Save Point Setup button, a tab display will be shown. The user can select Current Value, Max, Min, Peak, Average, or RMS for time signals or Peak, RMS, or Frequency of Peak for spectral data. In the Sound Level Meter function, Leq or Lmax can also be selected.

Using Schedule to Save Data

An automated schedule can be developed for recording the time streams, saving the block signals or data points.

1. Restart
2. Hold
3. Run Duration regardless Trigger
4. Run Duration after Trigger
5. Waiting for one time
6. LOOP
7. END LOOP
8. Limit check ON
9. Limit check OFF
10. Start Recording
11. Stop Recording
12. Save Signals
13. Turn signal source ON
14. Turn signal source OFF
15. Activate Timer to Save Signals
16. Deactivate Timer to Stop Saving Signals
17. Set all input mode

To make a schedule, first go to the Schedule Setup screen:
Insert appropriate entries into the schedule:

To activate the schedule, press the Display button for more than 3 seconds, then release the button.
To deactivate the schedule, press F6 Exit button in the signal display screen.

Recall Signals

Signals that are the result of a current measurement are named “live” signals. Occasionally it is helpful to compare live signals with previously saved signals and stored on the CoCo device. This can be done with the recall feature. Recalled signals can be overlaid with live signals for comparison or displayed in a separate window. Signals can also be un-recalled which removed them from all displays but does not affect the data saved on the CoCo.

To recall the signals that you just saved, press the Recall hard button.

To recall a signal that you previously saved, press the File Button, then press the F1 Files Button then press the F5 Review Button. Next use the up and down arrow buttons to highlight a signal to be recalled and press the F3 Recall Button. Next highlight a signal from the Record Files list and then press the F3 Recall Button.
The CoCo will show a menu listing all available windows that this signal can be recalled into. The last item is always “Recall the signal to a new window”. This item will create a new display window in the current active project and display the recalled signal into this window. Other selections will allow the recalled signal to be overlaid with the others.

After a signal is recalled, it can then be un-recalled. This removes the signal from the all displays however the original data file remains stored on the CoCo. To un-recall a signal, take one of the following two actions.

Method 1: In the above file menu, press F4 to see all signals that can be un-recalled. You can either un-recall one signal or un-recall all of them.

Method 2: Under the Traces menu, select the last command (Recalled Signal List):
Figure 133. Recall signals from the trace menu.

The recalled signals will have a signal name with a prefix of its file name. The recalled signals can be displayed in the same way as live signals.

Figure 134. Un-recall signal

Figure 135. Recalled signals appear with file name prefix.
The picture below shows a recalled signal in green color overlaid with a live signal in yellow.

Figure 136. Live signal overlaid with recalled signal.
EDM PC Software

This section briefly describes the Engineering Data Management (EDM) software that is used to download data from the CoCo-80 to a PC and to view, analyze and export that data. For details about EDM software installation and operation please refer to EDM User's Manual.

EDM provides connectivity to one or more CoCo or Spider devices. It provides data management tools that allow you to search through many tests, records and view file properties or waveform characteristics. The analysis tools allow you to display data in a wide variety of formats and configurations and let you identify important signal characteristics using cursors. The report tool allows you to document the hardware configuration or data analysis results in a user formatted document.

The figure below shows the basic structure of EDM.

![EDM Structure Diagram]

EDM has four working modes:

1. **CoCo-80 DSA mode**: accesses CoCo-80 in its DSA mode, download files and view data files. CSA Editor, a tool of editing CoCo testing projects, will be included in this mode.
2. **CoCo-80 VDC mode**: creates route data collection database, upload settings to CoCo, download data to PC, trending and alarm analysis. There are two versions of VDC modes: personal version allows the user access the database on his local PC. Enterprise version allows multiple user access the database on the LAN.

3. **Spider Real-Time Mode**: operates on Spider hardware in real-time.
4. **Post Analysis Mode**: analyzes the data files on PC using various algorithms. PA has three versions: PA Viewer allows the user to view the data and create report; PA Basic has FFT spectral analysis and 3D signal display functions; PA Premium has all post analysis functions.

EDM software is registered to a CoCo or a Spider device. To activate the EDM software, the user must have a License Key. EDM software uses a License Key file to enable or disable certain functions. The license key is also used to control the Activation Period and Software Subscription Renew period. Multiple license keys can be installed in one EDM installation. This allows an instance of EDM runs multiple hardware devices.

License keys are managed in the EDM License Key Management window, shown below.
Software Renew Period: this is the time period that this EDM installation can be upgraded using the current installed License Key. When the time expires, the EDM software will still be functional but cannot be updated.

Software Activation Period: this is the time period that this EDM installation can be used using this License Key.

The CoCo DSA Mode of EDM

The EDM Software functions as both the means of transferring data from the CoCo-80 to the PC and also as a data management and analysis tool. The main features of the software include: transferring data between the CoCo-80 and a PC, viewing, searching and exporting data to other formats and using the analysis tools to measure signal characteristics.

Data Transfer

After a connection is established between the CoCo-80 and a PC, the EDM software manages the transfer of data between the two devices. The data includes recorded time streams, saved signals, and CSA projects. When EDM detects the connection, the software displays a list of the files available for transfer and allows the user to initiate the download to the PC. After files are downloaded they can be deleted from the CoCo-80 flash memory to create free space for new data files.
Data Management

The nature of signal measurement generates a large number of records. The EDM software provides tools to manage this data to simplify searching, review and exporting the data. Data can be searched by key words, date or time, size or other file attributes. Data can be previewed via thumbnail representations of the data or by text file attributes. Data can be replayed within the search tool including the ability to scroll through a long time stream to verify that the record contains the required properties. EDM simplifies the process of exporting data from the native ASAM ODS format to other popular universal formats including UFF, BUFF and ASCII.

Data Analysis

The EDM software includes basic analysis tools that help measure signal characteristics such as zoom and pan and cursors. Multiple signals can be overlaid on one trace for comparison. Long time streams can be played back and time or frequency data can be displayed.

CoCo-80 - PC Communication

The first step in downloading data from the CoCo-80 to a PC is to establish communication between the two devices. CoCo-80 is equipped with a number of hardware connectivity functions for easy communication with a host PC. These include:

- USB port
- 100MbaseT Ethernet
- Wireless 802.11b/g using SD card

You can choose one of following four typical connections:

- Connect CoCo-80 to a PC directly using a USB cable
- Connect CoCo-80 to a PC directly using Ethernet via cross-over cable
- Connect CoCo-80 to a local network using Ethernet where a host PC resides on the local network
- Connect CoCo-80 to a local network using a wireless SD card

The table below summarized the configuration for these connections.
Table 4. PC to CoCo-80 Configuration Summary.

In this table, *DHCP (dynamic host configuration protocol) server* refers to a piece of software installed on the local area network, either wired or wireless, that supports the “Obtain an IP address automatically” function on any networked device. DHCP is commonly used in most office networks.

**Transfer Data Files to the Host PC**

To transfer the recorded data files to a PC, you must:

1. Establish a physical network connection between the CoCo-80 and a PC. This can be done by using either the Ethernet, USB-client port, or SD wireless card.
2. Execute the EDM software on the PC.
3. Download the data files from the CoCo-80 to PC using EDM software.

The data files will be automatically stored in the ASAM-ODS format. They can be converted into other formats with the EDM software.

**Configuring the CoCo-80 Network Settings**

CoCo-80 Network Settings must be configured when an Ethernet or SD Wireless card are used for communicating with the host. When USB is used for the connection, this section can be ignored.

To configure the network settings for the CoCo-80, complete the following steps:

1. Power on the CoCo-80. In the Welcome page, move the focus to Connections and press ENTER.

2. In the **IP Settings** window click **Edit the IP settings** to specify a static IP address and subnet mask. Type in the **IP address** and **Subnet mask**. You must specify a static IP address and use a crossover cable to directly connect the CoCo-80 to the host computer. In this case, both the Gateway and DNS server fields must be blank or set to zeroes. If the network uses a DHCP server and you are not directly connecting the CoCo-80 to the host computer with a crossover cable, click the **Obtain IP address via DHCP server** option button.

3. Click **OK** to apply the changes.

![Figure 139. Ethernet connection status.](image)
Figure 140. Specify a static IP address for the Ethernet connection.

**Access Code**: This is a special setup to prevent an unauthorized user from accessing the CoCo-80 on the LAN. It also provides a means for the EDM software to access a particular CoCo-80 on the network. The EDM requires the CoCo-80 Access Code to access it over the LAN.

**Configuring the Host PC Network Settings**

If the host system is a PC which is only connected directly to the CoCo-80 using a cross over Ethernet cable, you can manually configure the TCP/IP settings. You can also use the “alternate configuration” functionality to maintain seamless operations on both office and private networks without having to manually reconfigure the TCP/IP settings. Choose whichever method best applies to your system configuration and connectivity needs. Refer to the Microsoft support website for more information on “alternate configuration” [http://support.microsoft.com/kb/283676](http://support.microsoft.com/kb/283676).
**Note:** You must be logged onto the host system as an Administrator in order to change network settings. Contact the system administrator to get access to the necessary privileges.

**Connect CoCo-80 to a PC directly using USB client**

A USB connection is the easiest method to connect the CoCo-80 to a PC. This requires the following steps:

Install the EDM software on the PC. Install the RNDIS USB driver on the PC.

Connect CoCo-80 to the PC through the provided USB cable. This cable has a mini-client port connecting to the CoCo-80 and a flat USB port connecting to the PC.

**Connect CoCo-80 to a PC directly using Ethernet via crossover cable**

Another way to connect the CoCo-80 to a PC directly is to use the Ethernet port and a CAT-5 cross-over cable. The advantage of using Ethernet compared to USB is that the data transfer speed is faster with Ethernet. The disadvantage is that you must configure the IP settings on the host PC so it can communicate with the CoCo-80.

In this case, both PC and CoCo-80 must be configured with a fixed IP address with the same subnet mask. The host PC can also use the Alternative Configuration feature for convenient communication with its office local area network. Alternate Configuration is a networking option within Windows to maintain seamless operations on both office and home networks without having to manually reconfigure TCP/IP settings. Refer to the Microsoft support website for more information of this feature.

[http://support.microsoft.com/kb/283676](http://support.microsoft.com/kb/283676)

**Connect CoCo-80 to a local network using Ethernet**

In this connection case, if DHCP server is not installed on the local area network, both PC and CoCo-80 must be configured with a fixed IP address with the same subnet mask. If DHCP server is installed, then both the PC and the CoCo-80 can use the Obtain an IP address automatically function.

**Connect CoCo-80 to a local network using wireless SD card**

In this connection case, if DHCP server is not installed in the local area network, both PC and CoCo-80 must be configured with a fixed IP address with the same subnet mask. If DHCP server is installed, both the PC and the CoCo-80 can use the Obtain an IP address automatically function.
AmbiCom WL11 or WL54-SDIO Wireless LAN Card is a compact size wireless card for the SDIO capable PDAs and other SDIO compatible mobile computing device using Microsoft Windows Mobile 2003 and Windows Mobile 5.0 operating system. In addition to the slim and ultra lightweight SD design, the Wireless SD Card also features secure data transfer and full privacy, exceptional range and data rate, and meets Wi-Fi certification standards for total interoperability with other 802.11b/g equipment. More information is available at


**Network Connection Diagnosis**

The following section describes methods for diagnosing network connectivity from the CoCo-80 or the PC which may be helpful when setting up the network connection.

**Diagnosis from the CoCo-80 side**

A tool is provided to detect the existing network settings from the CoCo-80 side. Push the Setup button, and select the Connections icon and press the Enter button, the connection status is shown below:

![Network Connection Status Screen](image)

The network setting detection shows the following status:

**Hardware**: indicates whether the Ethernet, USB port or Wireless card inside the CoCo-80 device are functional.

**IP Address**: indicates the IP address of the CoCo-80.

**DHCP server**: indicate whether the CoCo-80 has detected a DHCP server on the local area network.
**EDM:** indicates whether CoCo-80 is connected to the EDM, the host software on a PC.

**Internet:** indicates whether the CoCo-80 is connected to the Internet.

**CI server:** indicates whether the CoCo-80 is detecting the Crystal Instruments server. The CI server is used to host new software to keep the CoCo-80 up to date.

**Diagnosis from the PC**
The connection between the CoCo-80 and a PC is managed within the EDM software on the PC. The EDM software provides connection diagnosis capability. The Connection Wizard dialog box will show one of following four connection pictures:

![Figure 143. EDM network connection status screen.](image)

Select appropriate connection type, and follow the online instructions. The EDM will provide diagnose information.

**Data Format**
The data format within the CoCo-80 and the EDM software is the ASAM ODS File format. ASAM ODS files have the suffix ATFX. EDM also interfaces to other file formats including NI-TDM, MatLab, UFF, BUFF and user-defined ASCII files.

**ASAM ODS (Open Data Service)**
The rapid progress in hardware and software leads to storage of data in many different data base systems as well as under different hardware and/or server generations. During development and production of complex products, a huge mass of data is produced. Today, data are stored within the automotive industry in a standardized format specified by the ASAM ODS workgroup. ASAM stands for *Association for Standardization of Automation and Measuring Systems*, and ODS stands for “Open Data Services”. The CoCo-80 uses the ASAM ODS data format as the internal data format and data is saved by default in this format when it is downloaded from the device to a PC.
The ASAM ODS standard has the fundamental quality of storing data with an architecture-independent method. This leads to great advantages when exchanging data between different sources and possible prospective customers.

Many systems in test, evaluation, and simulation environments have their own proprietary formats to store data. These formats usually are very different from each other regarding the description of the configuration (unit under test, test sequence, test equipment, etc.) as well as the way results are stored (database, binary files, etc.).

The main objectives for a standardization of data access interfaces are to reduce costs and risks within projects, and to provide a reliable basis for implementations in the area of data storage and data usage. Using standardized interfaces and common structures minimizes the efforts for the system integration within the heterogeneous environments discussed above and makes it much easier to exchange data.

Because of these benefits the ASAM ODS data format was chosen as the internal format for the CoCo-80 and the EDM software.

**UFF Files**

The CoCo-80 and EDM Software also support the Universal File format (UFF). This format was originally developed by the Structural Dynamics Research Corporation (SDRC) in the late 1960s and early 1970s to facilitate data transfer between computer aided design (CAD) and computer aided test (CAT) in order to facilitate computer aided engineering (CAE). SDRC, as part of EDS, continues to support and utilize the UF formats as part of their CAE software. Currently, MTS, Noise and Vibration Division supports and continues to develop IDEAS software in the test area that utilizes UF formats.

The formats were originally developed as 80 character (card image), ASCII records that occur in a specific order according to each UF format. As computer files became routinely available, single UF formats were concatenated into computer file structures. Recently, a hybrid UF file structure (UF Dataset 58 Binary) was developed for experimental data that allows data to be stored in a more efficient binary format.

Before the introduction of ASAM ODS, the use of the Universal File Format as a de-facto "standard" has been of great value to the experimental dynamics (vibration and acoustic) community, particularly in the area of modal analysis. Both users and vendors have benefited from this de-facto standard.

The EDM software will be able to export the data into UFF (Dataset 58) and BUFF (Dataset Binary 58). For more information on UFF refer to [http://www.sdrl.uc.edu/uff/uff.html](http://www.sdrl.uc.edu/uff/uff.html).
The Binary 58 Universal File Format (BUFF)

The CoCo-80 and EDM software also support the BUFF format. The basic (ASCII) universal file format for data is universal file format 58. This format is completely documented by SDRC and a copy of that documentation is on the UC-SDRL web site (www.sdrl.uc.edu/UFF2/58.asc). The universal file format always begins with two records that are prior to the information defined by each universal file format and ends with a record that is placed after the information defined by the format. First of all, all records are 80 character ASCII records for the basic universal file format. The first and last record are start/stop records and are always -1 in the first six columns, right justified (Fortran I6 field with -1 in the field). The second record (Identifier Record) always contains the universal file format number in the first 6 columns, right justified.

This gives a file structure as follows (where b represents a blank character):

```
bbbb-1
bbbbb58
...
...
...
bbbb-1
```

The Binary 58 universal file format was originally developed by the UC-SDRL in order to eliminate the need to compress the UFF 58 records and to reduce the time required to load the UFF 58 data records. The Binary 58 universal file format yields files that are comparable to compressed files (approximately 3 to 4 times smaller than the equivalent UFF 58 file). The Binary 58 universal file format loads approximately 30 to 40 times faster than the equivalent UFF 58 file, depending upon the computing environment. This new format was submitted to SDRC and subsequently adopted as a supported format.

The Binary 58 universal file format uses the same ASCII records at the start of each data file as the ASCII dataset 58 but, beginning with record 12, the data is stored in binary form rather than the specified ASCII format. The identifier record has the same 58 identifier in the first six columns, right justified, but has additional information in the rest of the 80 character record that identifies the binary format (the size of the binary record, the format of the binary structure, etc.).

```
-1
58b  x  y  11  zzzz  0  0
0  0
...
...
(11 ASCII header lines)
...
```
... (zzzz BINARY bytes of data, in format specified by x and y, above)
... (interleaved as specified by the ASCII dataset 58)
...

When reading or writing a dataset 58b, care must be taken that the binary data immediately follows the ASCII header lines and the closing ' -1' immediately follows the binary data. The binary data content is written in the same sequence as the ASCII dataset 58 (i.e. field order sequence). The field size is NOT used, however the data type (int/float/double) content is. Note: there are no CR/LF characters embedded in or following the binary data.

**ASCII UFF**

The CoCo-80 and EDM software also support the ASCII UFF format. The ASCII UFF file format is a form using the ASCII type to represent all the data sets. For details, see: [http://www.sdrl.uc.edu/uff2/58.asc](http://www.sdrl.uc.edu/uff2/58.asc)

**MATLAB file**

This is the standard file that can be imported into MatLab.

**NI-TDM file**

This is a structured data format that is defined and widely used by the LabVIEW from National Instruments.

**User Defined ASCII file**

This is the ASCII files where you have the freedom to define its attributes and header format.

**.CSV (Microsoft Excel) File**

This is the ASCII file that the Microsoft Excel can directly read.

**.WAV File**

This is the sound wave files that can be played by most of the media players. Due to limited information a wave file can carry, the wave files exported only contain very basic waveform shape and it does not hold any attribute information of ODS. You are expected to use the .WAV file to listen to its sound effect, instead of for data processing.
CSA Editor Operation for Spectral Analysis

This section describes the operation of CSA Editor related to FFT based spectral analysis. For general operation of CSA Editor, refer to the CSA User’s Manual.

CSA Editor Wizard

To start the CSA Editor, click on the CSA Editor icon in the upper-right corner in EDM. The CSA Editor Wizard dialog box will be displayed.

First, select the number of channels for the project based on the CoCo device it will run on.

![CSA Editor Wizard](image)

In the next screen, select the application template for the CSA project. Different templates have different functions available for signal processing. For FFT spectrum analysis, select Linear Spectrum, Auto Spectrum or Frequency Response. The software will open the CSA Application Group associated with the template that you choose.
The **Linear Spectrum** template can apply data conditioning to native time streams, transforms time streams into block signals, and does data windowing and FFT calculations to generate linear spectra.

**Auto Power Spectrum** is same as Linear Spectrum but can also calculate power spectra.

**Frequency Response** adds functions to calculate the cross spectra, Frequency Response Function (FRF), and coherence between two (or more) input channels.

Table 5 shows the functions available in the CSA templates. The other application groups, such Octave Analysis and Order Tracking Analysis, have more specialized functions and are not discussed here.
The Frequency Response template contains the most complete set of analysis functions. However, this does not mean that it is always the best template to use. Application groups with more measurement functions available require greater DSP resources. Heavy use of these resources, such as when using complex data conditioning, many channels, and high sample rates, will result in degradation of real-time computation ability.

Every CSA project has a parameter for *Maximum Sampling Rate*. If the processing requirements of the project are too high, this setting will have to be reduced. It is best to choose the lowest sampling rate that will be required for the application to conserve resources.

After the CSA Editor Wizard is finished, an empty project will be created. Data conditioning functions can be configured by connecting the data conditioning modules to time stream blocks under the Data Conditioning tab. For more details, refer to the CSA Editor User’s Manual.

### Select the Signals to Compute

The rest of this section assumes the Frequency Response template is used. With the other templates, some of these functions will not be available.

Under the Acquisition Mode tab, time stream signals can be selected for block acquisition. This is the process by which time streams are converted to a series of blocks. These block signals are then available for spectrum analysis functions such as Auto Power Spectrum and Frequency Response Functions. Time stream signals include the native channel sources and the output of data conditioning modules. Selecting “Set as Trigger Source Candidate” also enables the channel to

---

The table below compares measurement quantities for different spectral analysis templates.

<table>
<thead>
<tr>
<th>CSA Template</th>
<th>Time streams of native channels</th>
<th>Time streams for each data conditioning output</th>
<th>Acquisition Mode, Blocked Time Capture</th>
<th>FFT and Auto-Power Spectra</th>
<th>Cross Spectra</th>
<th>FRF/Coh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Conditioning Only</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Transient Capture</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Linear Spectrum</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Auto Power Spectrum</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Frequency Response</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 5. Comparison of measurement quantities for different spectral analysis templates.
be used as a trigger source in triggered acquisition modes. See __________ for more details.

The Signal Analysis tab has two sections. The upper half shows all available block signals, which are all the signals under the Acquisition Mode tab that do not have “No Block Acquisition” selected. The bottom half shows the available spectral analysis functions available for these block signals.

EDM uses a consistent naming convention for all signals. Time stream signals have a name, such as CH1, that identify its source. Signals derived from the time
streams are named by the function that generated them followed by the source time stream signal in parenthesis. The types of signals include:

- **CHn**: the native time stream signal of the nth input channel
- **BLOCK(sig)**: the block signal acquired from the time stream sig
- **APS(x)**: the Auto Power Spectrum of time stream x
- **CPS(y,x)**: the Cross Power Spectrum of excitation x and response y
- **COH(y,x)**: the coherence function of the excitation x and response y
- **FRF(y,x)**: the FRF of excitation x and response y

Signals enabled as **Display Candidates** will be selectable for display on the CoCo, and signals enabled as **Save Candidates** will be selectable for block data saving. Disabling some signals for Save and Display ability will simplify the interface on the CoCo.

For FRF and CPS, one signal must be selected as the excitation channel. The other channels become the response channels. The FRF, CPS, and COH functions are available for the response channels with the excitation channel as the reference.

**Editing an Arbitrary Waveform**

The CoCo output channel can generate an arbitrary waveform from a file which can be programmed in the EDM software and uploaded to the CoCo.

To open the Arbitrary Waveform Editor in EDM, right click on “Arbitrary Waveform Files”.

To draw a waveform by hand, click and hold the mouse button then draw the desired Arbitrary waveform on the top half of the window.
After the waveform is completed, the value of each point can be changed by entering the value into the box.

**New Arb Wave** - creates a blank pane for another arbitrary waveform.

**Copy and Paste** let you copy the current waveform into a new waveform.

**Export** lets you save the arbitrary waveform as a text file which can be opened in a text editor or spreadsheet.

**Import** lets you import an arbitrary waveform that is saved as a text file.

You can also right click on the name of waveform. This opens a pop up menu with copy, paste delete, export, and import.

Finally, Right click on the arbitrary waveforms and upload them. Then the arbitrary waveforms are ready to be output in CoCo.
Finally click on the Send to CoCo button to save the arbitrary waveform file on the CoCo hardware.

Validation

After the CSA Wizard is complete and the CSA file is created, connect the host PC to the CoCo device and press the Validate icon to validate the CSA. It may take a few minutes to finish the validation.

The validation process analyzes the CSA file for internal consistency and estimates the required DSA resources required to run the CSA file on the CoCo device.

If the Validation passes, then press Send to CoCo command in the Validation dialog box to send the CSA project file to CoCo. Alternatively you can manually upload it to CoCo. The CSA uploaded will be classified into different CSA Application Groups based on the template that was used.

Advanced Audio Functions

CoCo-2, CoCo-80 and CoCo-90 are all equipped with advanced audio functions. These audio functions allow you to listen to the vibration or any measurement quantity or record voice annotations during signal recording. This document describes how to use the audio functions.

The advanced audio features can be summarized as following:
1. You can listen to any measurement input using headphones without interrupting the measurement or recording process. The audio monitoring is automatically scaled to the listening range and the headphone audio can be manually adjusted.

2. You can record voice annotations at any time and length during time stream recording.

3. A customized microphone is available with a push button to control voice annotation recording.

4. Voice annotations can be replayed on the CoCo hardware through headphones.

5. Voice annotations are attached to each recorded file, and can be played back on the PC using the EDM software.

6. CoCo can play back any recorded time streams using its output port. The output port can drive another audio device such as headphones or external speakers.

These advanced audio functions require the following minimum hardware and software versions: CoCo Software Version ≥ 1.7.8; Base Hardware System Version ≥ 2.0.9; Measurement Hardware Version ≥ 10.1.0; Firmware Version ≥ 1.5.0.

**Hardware Audio Peripherals**

Three hardware audio peripherals are used for the advanced audio functions:

1. Internal Speaker
2. External Headphone
3. External Microphone

The internal speaker is used to generate system-related signals, such as the sound simulating the key press, power-on/off or alarm. Voice annotations and measurement input audio can only be played back through headphones and not through the internal speaker.

The external headphone jack uses the 3.5mm stereo jack connector. You can connect any headphone to this connector.
The headphone jack is located at the second to the left with a headphone symbol. Voice annotations and measured input audio can be played back through the headphones.

The external microphone must be ordered from CI. It is designed so that when the microphone button is pushed, the voice annotation recording is activated. The microphone jack connector is on the left side of the peripheral panel. Do not use any microphone other than the specified CI microphone because without the microphone button hardware, you will not be able to start a voice annotation recording.

**Figure 145 Microphone with push button (part # CoCo-A12)**

**Audio Functions**

The audio functions are controlled through the CoCo, Setup/Other/Audio screen.
Keypad Sound: Enable and select the internal speaker sound output when any of the buttons are pressed.

Power Button Sound: Enable and select the internal speaker sound output when the power button is pressed.

Alarm Sound: Enable and select the internal speaker sound output for system alarms.

Use microphone to record the voice annotation: Enable the external microphone recording function. When this item is checked and the user presses the connected microphone button, the voice annotation is recorded until the button is released. Multiple annotations can be recorded during a measurement. If this item is not checked, the microphone button will not activate any voice recording.

Use headphone to listen to any input channel: Enable the external headphone listening function.

Headphone Listening

When Use headphone to listen to any input channel is enabled, under the Control (F3) menu of the signal display screen, you will see the Audio Playing... item. The input channels to listen to in both the left and right side can be set here. If you do not want to listen to the input channels, then set the selection to “System Sound or Recorded Annotations.”
Record Voice Annotations

After *Use microphone to record the voice annotation* is checked in the audio setup, connect the external microphone (Part #CoCo-A12) to the microphone jack. Press the Rec/Stop button to record the time signals. While the time signals are being recorded, you can press the microphone button to record your voice annotation. The voice annotations will be attached to the recorded time streams. The green bar on the right bottom corner on the screen indicates the volume of the signal received by the microphone.

Playback the Voice Annotations on CoCo

To play back the voice annotation, first press the File button, then the F1 Files, then the F2 Voice button.
The F3 Play button allows you to hear the previously recorded voice annotation. Then you can use the F1 Previous Annotation or F2 Next Annotation Buttons to play all the annotations. If the Voice button is not shown, it means the signal file saved has no voice annotation attached.

Voice annotations will be listed under each recorded or saved signal files and can be played back with EDM PC software.

**Playback the recorded signals from output channel**

The CoCo can playback any of the recorded signals from its output channel. To do so, open a recorded file and press F5 the Playback button.
If the user made voice annotations while the time stream is recorded, the voice annotations will be played back as well.

After the signal playback is finished, the screen will show the message *Waveform playback finished.*
Notice that the recorded signal will be played back at the sampling speed of when it was acquired. Inside CoCo, the A/D converters and D/A converter share the same sampling clock. Due to this design, when the signal is played back, input signal cannot be analyzed.

Appendix

Versions

<table>
<thead>
<tr>
<th>Version</th>
<th>Release Date</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>8/01/07</td>
<td>First Draft</td>
</tr>
<tr>
<td>0.90</td>
<td>11/12/07</td>
<td>Revised</td>
</tr>
<tr>
<td>0.94</td>
<td>2/15/08</td>
<td>Many pictures added</td>
</tr>
<tr>
<td>0.99</td>
<td>7/16/08</td>
<td>Basic manual includes basic, spectral analysis and impact testing.</td>
</tr>
<tr>
<td>1.01</td>
<td>2/3/09</td>
<td>Move built-in integration from Advanced to here</td>
</tr>
<tr>
<td>1.2</td>
<td>7/16/09</td>
<td>Add descriptions for added 6 buttons. Minor changes</td>
</tr>
<tr>
<td>1.3</td>
<td>1/27/2010</td>
<td>Add playback function. Change CI address</td>
</tr>
<tr>
<td>1.3.1</td>
<td>6/25/2010</td>
<td>Major cleanup by A Snyder</td>
</tr>
<tr>
<td>1.5</td>
<td>3/19/2012</td>
<td>Major edit by M Mu</td>
</tr>
</tbody>
</table>
Declaration of Conformity

Declaration of Conformity for CI CoCo-80, Handheld Data Acquisition System

Manufacturer: Crystal Instruments Corporation, 2370 Owen Street, Santa Clara, CA 95054

EC Declaration of Conformity


Crystal Instruments, 2370 Owen Street, Santa Clara, CA 95054, USA.

Product Name: CoCo-80 (Handheld Data Acquisition System)

Model No.: CoCo-80

Assessment of compliance of the product with the requirement relating to Electromagnetic Compatibility Directive. The product has been assessed by the application of the following standards:

EN61000-3-2: 2000

The tests have been performed in a typical configuration.

This Conformity is indicated by the symbol, i.e. “Conformité Européenne”. 